The Drive & Control Company

Rexroth
Bosch Group

Hydraulic Hybrid from Rexroth Hydrostatic Regenerative Braking System HRB

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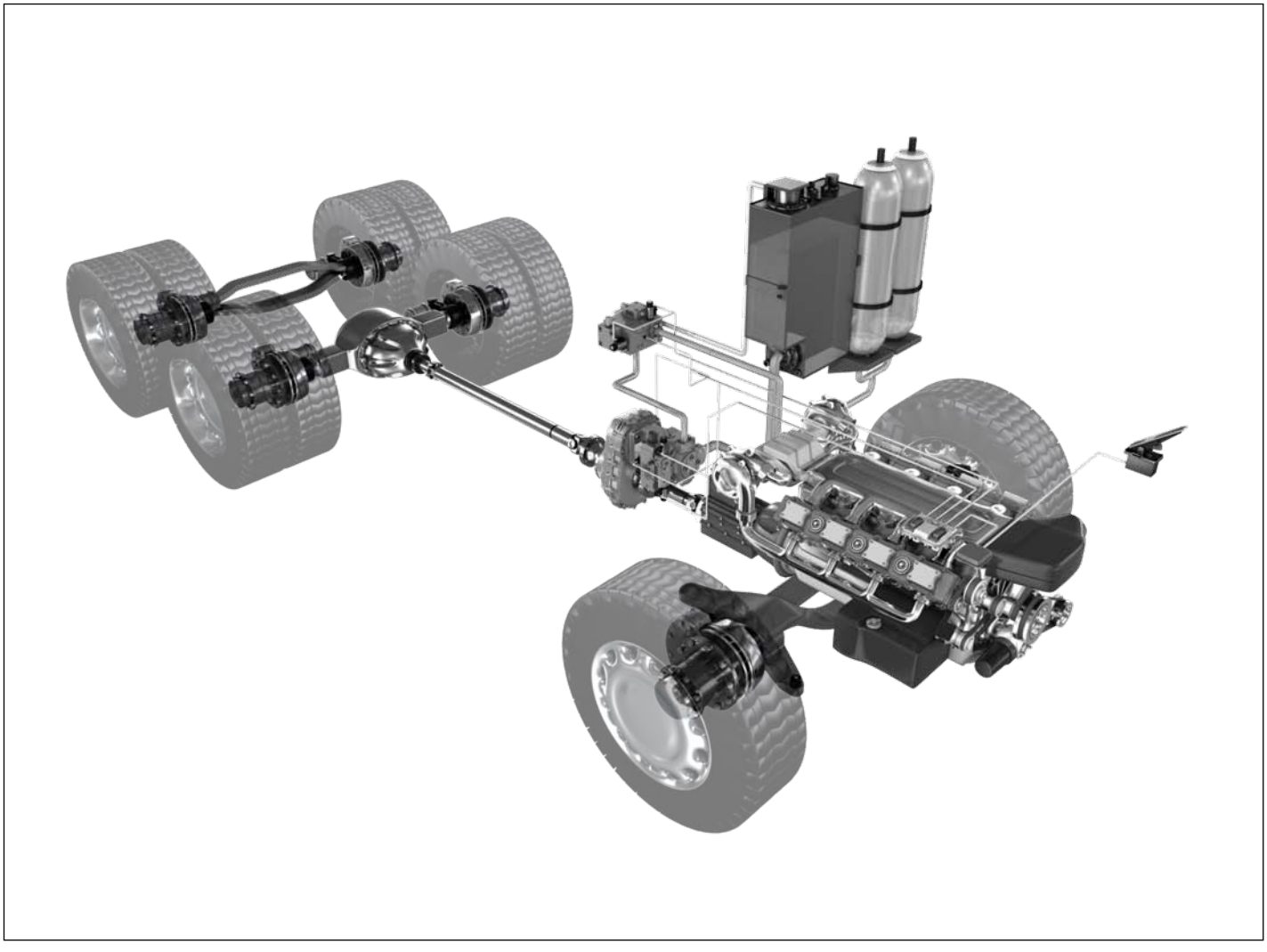

The data specified above serve to describe the product. Should information be provided on use, these are only examples of applications and suggestions. Information from the catalog are not assured properties. The information given does not release the user from the obligation of own judgment and verification. Our products are subject to a natural wear and aging process.

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The cover shows an example application. The product delivered may differ from the image on the cover.

The original instruction manual was created in the German language.

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1 About this manual

1.1 Validity of the documentation

This documentation applies to the following products:
• Hydrostatic Regenerative Braking System HRB

This documentation is intended for vehicle manufacturers, fitters and service technicians.
This documentation contains important information on the safe and appropriate transport, installation, commissioning, operation, maintenance, removal and simple troubleshooting of the HRB hydrostatic regenerative braking system.

- Read this documentation completely, in particular chapter 2 "Safety instructions" on page 9 and chapter 3 "General instructions on damage to equipment and the product" on page 15, before you start work with the HRB hydrostatic regenerative braking system.

1.2 Required and supplementary documentation

- Only commission the HRB hydrostatic regenerative braking system if the documentation marked with the book symbol 🕮 is available to you and you have understood and observed it.

Table 1: Required and supplementary documentation

	Title	Document number	Document type
🕮	**Hydraulic hybrid from Rexroth** **HRB hydrostatic regenerative braking system** Contains the permissible technical data.	RE 94850	Data sheet
🕮	**Installation drawings** Contains the outer dimensions and details of all ports for the HRB. These documents are sent once only with the initial documentation.		Installation drawings
🕮	**Electrical circuit diagram** Electrical circuit diagram for the HRB. This document will be sent once only with the initial documentation.		Electrical circuit diagram
🕮	**Hydraulic circuit diagram** Hydraulic circuit diagram for the HRB. This document will be sent once only with the initial documentation.		Hydraulic circuit diagram
🕮	**Hydraulic hybrid from Rexroth** **HRB hydrostatic regenerative braking system** Describes the interfaces between the vehicle and the HRB. This document will be sent once only with the initial documentation.	RE 94850-40-B	Interface description/data network concept

If you do not have the initial documentation in its entirety on hand, contact your responsible Bosch Rexroth sales organization.

1.3 Display of information

Standardized safety instructions, symbols, terms and abbreviations are used so that you can use this documentation to work quickly and safely with your product. To give you a better understanding they are explained in the sections below.

1.3.1 Safety instructions

This documentation includes safety instructions in chapter 2.6 "Product-specific safety instructions" on page 11 and in chapter 3 "General instructions on damage to equipment and the product" on page 15 and before a sequence of actions or an instruction for action involving a risk of personal injury or damage to equipment. The described danger prevention measures must be observed.

Safety instructions are set out as follows:

⚠ SIGNAL WORD

Type and source of danger!
Consequences in case of noncompliance
- ▶ Measure for danger prevention
- ▶ <List>

- **Safety signs:** draw attention to danger
- **Signal word:** identifies the degree of the danger
- **Type and source of danger:** identifies the type and source of the danger
- **Consequences:** describes what occurs if the safety instructions are not complied with
- **Precautions:** states how the danger can be avoided

Table 2: Danger classes in accordance with ANSI Z535.6-2006

Safety sign, signal word	Meaning
⚠ DANGER	Identifies a dangerous situation that will result in death or serious injuries if it is not avoided.
⚠ WARNING	Identifies a dangerous situation that may result in death or serious injuries if it is not avoided.
⚠ CAUTION	Identifies a dangerous situation that may result in minor to moderate injuries if it is not avoided.
NOTE	Property damage: The product or the environment may be damaged.

1.3.2 Symbols

The following symbols mark notes that are not safety-relevant but which increase the understanding of the documentation.

Table 3: Meaning of the symbols

Symbol	Meaning
	If this information is disregarded, the product can not be used and/or operated to the optimum extent.
▶	Single, independent step
1. 2. 3.	Numbered instruction: The numbers specify that the steps are completed one after the other.

1.3.3 Designations

This documentation uses the following designations:

Table 4: Designations

Designation	Meaning
HRB	**H**ydrostatic **R**egenerative **B**rake system (hydraulic hybrid)
Threaded plug	Metal screw, pressure-resistant
Protective plug	Made out of plastic, not pressure-resistant, only for transportation

The designation HRB will be used as an umbrella term for the "HRB hydrostatic regenerative braking system".

1.3.4 Abbreviations

This documentation uses the following abbreviations:

Table 5: Abbreviations

Abbreviation	Meaning
ABS	**A**nti-locking **B**rake **S**ystem
ADR	**A**ccord européen relatif au transport international des marchandises **D**angereuses par **R**oute (European agreement concerning the international transportation of hazard goods on the road)
CAN	**C**ontroller **A**rea **N**etwork
CCM	**C**ustomer **C**ontrol **M**odule
DIN	**D**eutsche **I**ndustrie **N**orm (German Institute for Standardization)
EN	**E**uropean **N**orm (standard)
h	Operating **h**ours
HCU	HRB control unit (**H**RB **C**ontrol **U**nit)
ISO	**I**nternational **O**rganization for **S**tandardization
PSM	**P**rogrammable **S**pecial **M**odule
RE	**R**exroth document in the **E**nglish language
SOC	**S**tate **O**f **C**harge
TCS	**T**raction **C**ontrol **S**ystem
VDI 2230	Directive for the systematic calculation of high duty bolted joints and joints with one cylindrical bolt from the VDI (**V**erein **D**eutscher **I**ngenieure – Association of German Engineers)

2 Safety instructions

2.1 About this chapter

The HRB has been developed in accordance with the generally accepted rules of current technology. There is, however, still a danger of personal injury or damage to equipment if this chapter and the safety instructions in this documentation are not complied with.

- Read this documentation completely and thoroughly before commissioning the HRB.
- Keep this documentation in a location where it is accessible to all users at all times.
- If the vehicle in which the HRB is fitted is handed over or sold on to a third party, it must always be accompanied by the required documentation.

2.2 Intended use

The HRB is designed for use in commercial vehicles and mobile working machines. The product is exclusively intended to be installed in the vehicle type specified in the order confirmation. The product may only be commissioned after it has been installed in the vehicle.

When the HRB is in use, kinetic energy is converted into potential energy and stored in hydro-pneumatic pressure accumulators. During subsequent acceleration, the stored energy is fed back into the travel drive, relieving the driving combustion engine.

The product may be used as follows:

- The HRB may only be installed in the vehicle defined in the order confirmation.
- Observe the technical data, application and operating conditions and performance limits as specified in data sheet RE 94850 and in the order confirmation.
- Only the system components supplied may be installed. These must be used in accordance with the circuit diagrams for the specific system (see order confirmation and specific vehicle configuration).

Intended use includes having read and understood the complete documentation, especially the chapter 2 "Safety instructions" on page 9.

2.3 Improper use

Any use other than that described as intended use shall be considered as improper and is therefore impermissible.

Bosch Rexroth AG shall accept no liability whatsoever for damage resulting from improper use. The user shall bear all risks arising from improper use.

Improper use of the product includes:

- Use in an explosive environment.
- Use in hazardous goods transporters.

2.4 Personnel qualifications

The activities described in this documentation require basic mechanical, electrical and hydraulic knowledge, as well as knowledge of the associated technical terms. For transporting and handling the product, additional knowledge is necessary with regard to working with a lifting device and the corresponding attachment equipment. In order to ensure safe use, these activities may therefore only be performed by appropriate qualified personnel or an instructed person under the direction and supervision of qualified personnel.
Qualified personnel are those who can recognize possible hazards and institute the appropriate safety measures due to their professional training, knowledge, and experience, as well as their understanding of the relevant regulations pertaining to the work to be done. Qualified personnel must observe the rules relevant to the subject area and have the necessary hydraulic knowledge.
Hydraulic knowledge means, for instance:

- reading and fully understanding hydraulic plans,
- fully understanding in particular the interrelationships regarding safety devices, and
- having knowledge on the function and assembly of hydraulic components.

Installation, commissioning, removal, care and maintenance of the HRB must only be performed in accordance with the Rexroth specifications in this manual and with the documents listed in Table 1 "Required and supplementary documentation" on page 6 or in accordance with instructions given by Bosch Rexroth Service.
Please consult your responsible Bosch Rexroth Customer Support Agent.

Operation of the HRB requires extensive knowledge of the information given in chapter 9 "Operation" on page 60 of this document.

2.5 General safety instructions

- Observe the applicable accident prevention and environmental protection regulations.
- Observe the safety regulations and provisions of the country in which the product is used/operated.
- Use Rexroth products only when they are in good technical order and condition.
- Observe all notes on the product.
- Persons who install, commission, operate, remove or maintain Rexroth products must not consume any alcohol, drugs or pharmaceuticals that may affect their ability to respond.
- Only use Rexroth original accessories and spare parts to ensure there is no risk to persons from unsuitable spare parts.
- Conform to the technical data and ambient conditions specified in the product documentation.
- If unsuitable products are installed or used in applications that are of relevance to safety, unexpected operating conditions may occur in the application which could result in injury to persons or property damage. For this reason, only use the product in a safety-relevant application if this use is expressly specified and permitted in the product documentation, for example in ex-protection applications or in safety-related parts of a control system (functional safety).

- You may only commission the product if it has been determined that the end product (e.g. machinery or a system) into which the Rexroth products are installed complies with the country-specific provisions, safety regulations and standards of the application.

2.6 Product-specific safety instructions

The following safety instructions apply for chapters 6 to 14.

⚠ DANGER

Vehicles that are not at a standstill pose a risk of injury!

Working on operating vehicles poses a danger to life and limb. The work steps described in this chapter must only be performed on stationary vehicles. Before beginning work:

- Ensure that the engine cannot be switched on. Remove the ignition key.
- Secure the vehicle against unexpected movement, e.g. with chocks.
- Ensure that all power-transmitting components and ports (electric, pneumatic, hydraulic) are switched off according to the manufacturer's instructions and are secured against being switched on again. If possible, disconnect the vehicle battery.
- Make sure all the vehicle is relieved of all hydraulic load. Please comply with the specifications of the vehicle manufacturer.
- The HRB may only be installed by qualified personnel (see chapter 2.4 "Personnel qualifications" on page 10).

Risk of injury from freely accessible HRB components!

Freely accessible HRB components constitute an increased risk of injury, e.g., through burning on hot parts or similar. Also in the event of a malfunction, burst high-pressure components (e.g., hoses, hydro-pneumatic pressure accumulator etc.) or leakage within the hydraulic system could cause injury.

- The HRB components must be installed so that they are not freely accessible.
- Make sure that the high-pressure components are suitably protected against bursting (e.g. by protective hoses and screening plates).

Pressure accumulators are pressurized!

Danger to life or risk of injury from bursting or exploding pressure accumulators.

- No welding, soldering, drilling or other work that could affect the mechanical properties is to be performed on hydro-pneumatic pressure accumulators.
- Do not modify the hydro-pneumatic pressure accumulator or its components.

⚠ WARNING

Danger from excessively high pressure!
Danger to life or risk of injury, damage to equipment!
Incorrectly changing the factory pressure setting can cause pressure to increase beyond the permissible maximum pressure.
Operating the unit above the permissible maximum pressure can cause components to burst and hydraulic fluid to escape under high pressure.

- Changes to the factory settings must only be made by Bosch Rexroth specialist personnel.

Danger from suspended loads!
Danger to life or risk of injury, damage to equipment!
Improper transportation may cause the HRB to fall down and could lead to injuries, e.g., crushing or broken bones or damage to the product.

- Make certain that the forklift truck or lifting device has adequate lifting capacity.
- Never stand under or put you hands under suspended loads.
- Ensure your position is stable during transportation.
- Use your personal protective equipment (e.g. safety glasses, safety gloves, suitable working clothes, safety shoes).
- Use suitable lifting devices for transportation.
- Observe the prescribed position of the lifting strap.
- Observe the national laws and regulations on work and health protection and transportation.

Pressurized vehicle!
Danger to life or risk of injury, serious injuries when working on a vehicle that is not shutdown! Damage to equipment!

- Secure the vehicle against being switched back on again.
- If present, always depressurize the body hydraulics. Comply with the specifications of the body or vehicle manufacturer.
- Do not disconnect any line connections, ports and components while the vehicle is pressurized.
- Switch off all power-transmitting components and ports (electric, pneumatic, hydraulic, mechanical) in accordance with the manufacturer's instruction and secure them against being switched back on.

Pressure accumulators are pressurized!
Danger to life or risk of injury, serious injuries when working on hydro-pneumatic pressure accumulators! Damage to equipment!

- Note that hydro-pneumatic pressure accumulators remain under high pressure even when the system is switched off.
- Please comply with relevant safety regulations when working with nitrogen gas in the hydro-pneumatic pressure accumulator.
- Please note further documentation about working with hydro-pneumatic pressure accumulators.

⚠ WARNING

Escaping oil mist!

Risk of explosion, fire, health hazard, environmental pollution!

- Depressurize the vehicle and repair the leak.
- Only perform welding work then the vehicle is depressurized and the vehicle battery is completely disconnected.
- Keep hydraulic lines and HRB components away from open flames and ignition sources.
- If hydraulic lines and HRB components are to be situated in the vicinity of ignition sources or powerful thermal radiators, a shield must be erected to ensure that any escaped hydraulic fluid cannot ignite and to protect hose lines from premature aging.

Electrical voltage!

Risk of injury due to electric shock or damage to equipment!

- Always de-energize the vehicle (ignition off, if necessary vehicle battery disconnected) before installing the product or connecting/disconnecting connectors. Secure the vehicle against being switched back on again.

⚠ CAUTION

High noise development in operation!
Danger of hearing damage, deafness!
Noise emissions from the axial piston unit and gearbox assembly depend on, among other factors, speed, operating pressure and installation conditions. The sound pressure level may rise above 70 dBA during normal application conditions.
- Always wear hearing protection when in the vicinity of the operating axial piston unit and gearbox assembly.

Hot surfaces on the HRB components!
Risk of burns!
- Allow the HRB components to cool down sufficiently before touching them.
- Wear heat-resistant protective clothing, e.g. gloves.

Improper routing of cables and lines!
Tripping hazard and damage to equipment!
- Lay cables and lines so that they can not be damaged and nobody can trip over them.

Contact with hydraulic fluids or lubricating oil!
Hazard to health/health impairment e.g. eye injuries, skin damage, toxication during inhalation!
- Avoid contact with hydraulic fluids or lubricating oil.
- When working with hydraulic fluids and lubricating oils, strictly observe the manufacturer's safety instructions.
- Use your personal protective equipment (e.g. safety glasses, safety gloves, suitable working clothes, safety shoes).
- If hydraulic fluid or lubricating oil should, nevertheless, come into contact with your eyes or bloodstream or is swallowed, consult a doctor immediately.

Escaping hydraulic fluid or lubricating oil due to vehicle leakage!
Risk of burns and risk of injury due to escaping oil jet!
- Depressurize the vehicle and repair the leak.
- Never attempt to block or seal the leak or oil jet with a cloth.

2.7 Personal protective equipment

The personal protective equipment is the responsibility of the user of the HRB.
Observe the safety regulations and provisions of your country.
All components of the personal protective equipment must be intact.

3 General instructions on damage to equipment and the product

The following instructions apply for chapters 6 to 14.

NOTE

Danger from improper handling!

Product can be damaged!

- Do not expose the product to an impermissible mechanical load.
- Never use the product as a handle or step.
- Do not place/lay any objects on the product.
- Do not strike the flange of the axial piston unit and gearbox assembly.
- Do not place or set the axial piston unit and gearbox assembly down on the flange.
- Carefully set down the axial piston unit and gearbox assembly.
- Do not strike fittings (e.g. sensors or valves).
- Do not strike sealing surfaces (e.g. service line ports).
- Leave the protective covers on the axial piston unit until shortly before the lines are connected.
- Before performing any electro-welding and painting operations on the vehicle, the battery must be completely disconnected.
- Make certain that the electronic components (e.g., sensors) do not become electrostatically charged (e.g., during painting operations).

Damage to equipment due to improper lubrication!

Product can be damaged or destroyed!

- Never operate the axial piston unit and gearbox assembly with insufficient hydraulic fluid or lubricating oil. Make sure in particular that the rotary group has sufficient lubrication.
- When commissioning the vehicle, make sure that the case and the suction and service lines of the axial piston unit and gearbox assembly are filled with hydraulic fluid or lubricating oil and remain filled during operation.
- Check the level of the hydraulic fluid and lubricating oil regularly; if necessary, recommission.
- Make sure that the suction line is always filled with hydraulic fluid during commissioning and operation and that it is free of leaks.
- Make sure that the axial piston unit really does suck in hydraulic fluid and build up pressure.

NOTE

Mixing of hydraulic fluids!

Product can be damaged!

- Before installation, remove all fluids from the axial piston unit to prevent mixing with the hydraulic fluid used in the machine/system.
- Any mixing of hydraulic fluids of different manufacturers or different types of the same manufacturer is not permissible in general.

Contamination of the hydraulic fluid or of the lubricating oil!

The cleanliness of the hydraulic fluid and lubricating oil has a considerable impact on the cleanliness and service life of the hydraulic system. Contamination of the hydraulic fluid could cause premature wear and malfunctions!

- Make sure that the working environment at the installation site is fully free of dust and foreign substances in order to prevent contaminants from getting into the hydraulic lines and causing product wear and malfunctions. The HRB components must be installed in a clean condition.
- Use only clean ports, hydraulic lines and attachments (e.g. measuring device).
- No contaminants may enter the ports when they are plugged.
- Before commissioning, make sure that all hydraulic connections are tight and that all of the connection seals and plugs are installed correctly to ensure that they are leakproof and fluids and contaminants are prevented from penetrating the product.
- To fill the axial piston unit and the HRB clutch with hydraulic fluid, use a fine filter/filling unit with a microglass element and a fineness of 3 µm.
- To fill the gearbox with lubricating oil, use a fine filter/filling element with a microglass element and a fineness 3 µm.

Improper cleaning!

Product can be damaged!

- Plug all openings with the appropriate protective equipment in order to prevent detergents from entering the hydraulic system.
- Never use solvents or aggressive detergents. Use only water and, if necessary, a mild detergent to clean the HRB components.
- Do not point the power washer at sensitive components, e.g. seals, electrical components and plug connections.
- Use lint-free cloths for cleaning.

NOTE

Environmental pollution due to incorrect disposal!
Careless disposal of the product, the hydraulic fluid, the lubricating oil and the packaging material could lead to pollution of the environment!

- For this reason, dispose of the product, the hydraulic fluid and lubricating oil as well as the packaging in accordance with the currently applicable environmental regulations in your country.
- Dispose of the hydraulic fluid and lubricating oil in accordance with the applicable safety data sheet for the hydraulic fluid and lubricating oil manufacturer.
- In particular, make sure that the oil and gas pressure accumulators are depressurized.

Escaping or spilling hydraulic fluid or lubricating oil!
Environmental pollution and contamination of the ground water!

- When filling and draining the hydraulic fluid or lubrication oil, always place a drip tray under the axial piston unit and gearbox assembly.
- Use an oil binding agent if hydraulic fluid or lubricating oil is spilled.
- Observe the information in the safety data sheet for the hydraulic fluid and lubricating oil and the specifications provided by the system manufacturer.

The warranty applies only to the delivered configuration.
The entitlement to warranty cover will be rendered void if the product is incorrectly installed, commissioned or operated, or if it is used or handled improperly.

4 Delivery contents

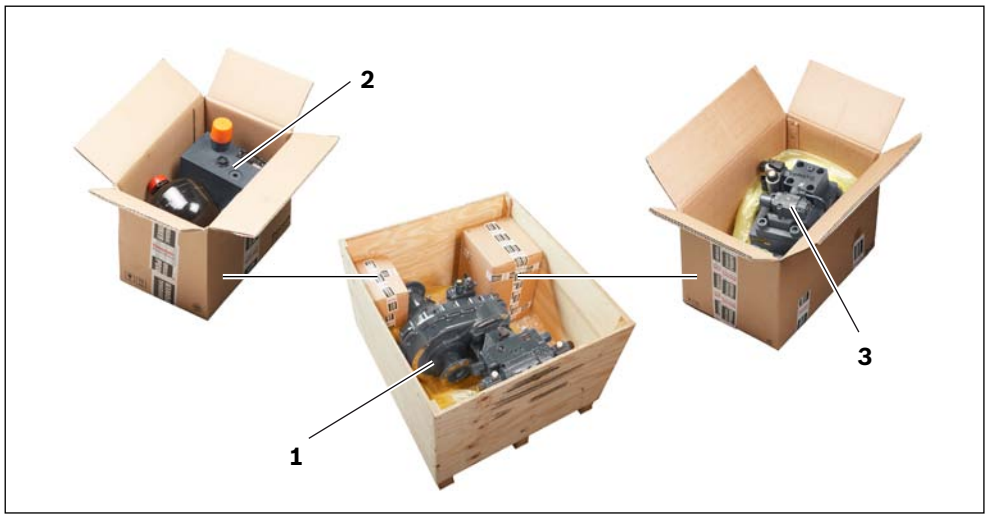

Fig. 1: Delivery contents of the HRB hydrostatic regenerative braking system

The following components of the HRB are included in the delivery contents:

- Axial piston unit and gearbox assembly pre-installed (**1**)
- Pilot oil supply manifold with pilot oil accumulator ready and pre-charged (**2**)
- HRB manifold (**3**)
- HRB control unit (HCU)
- Pressure sensors for accumulator pressure, pressure at axial piston unit, pilot oil pressure
- Temperature sensors for accumulator shell and reservoir
- Plastic plugs/threaded plugs for all hydraulic components
- Hydro-pneumatic pressure accumulator pre-charged with approx. 5 (see figFig. 2)
- Mating connector with contacts for all electric components

Fig. 2: Delivery contents of hydro-pneumatic pressure accumulator

5 About this product

5.1 General system description

The regeneration of braking energy is a useful way of optimizing the total efficiency of a mechanical drive train.
The greatest optimization potential is realized in cyclical driving operation (frequent braking and acceleration). The cycles encountered in "refuse collection" applications are especially suitable.
For applications with high power conversion and only very low quantities of energy, hydraulic solutions are superior to other solutions because of the high power density.
When this system is used in applications with extremely short working cycles, fuel consumption can be reduced by up to 25 %.
Another effective economic benefit of the HRB is considerably reduced brake wear and tear and thus longer intervals between replacement and maintenance.
The HRB unit described here is suitable for vehicles with both automatic and semi-automatic gearboxes.
Refer to the data sheet and order confirmation for the technical data, operating conditions and operating limits of the axial piston unit and gearbox assembly.

5.2 Function principle

The principle of the HRB hydrostatic parallel hybrid solution, which is also suitable for retrofitting, is shown in Fig. 3. The components shown in blue are included in the HRB delivery contents.

Here, a hydrostatic axial piston unit (**3**) is coupled in the drive train to the gearbox output (**1**) via a shiftable gear (**2**). In pump mode, this charges a hydro-pneumatic pressure accumulator (**4**) to generate a braking torque at the output drive (**5**) or which can utilize the accumulator pressure in motor mode to add an acceleration torque to the cardan shaft. In addition, an HRB manifold (**6**) provides the necessary pressure safeguarding and shut-down functions.

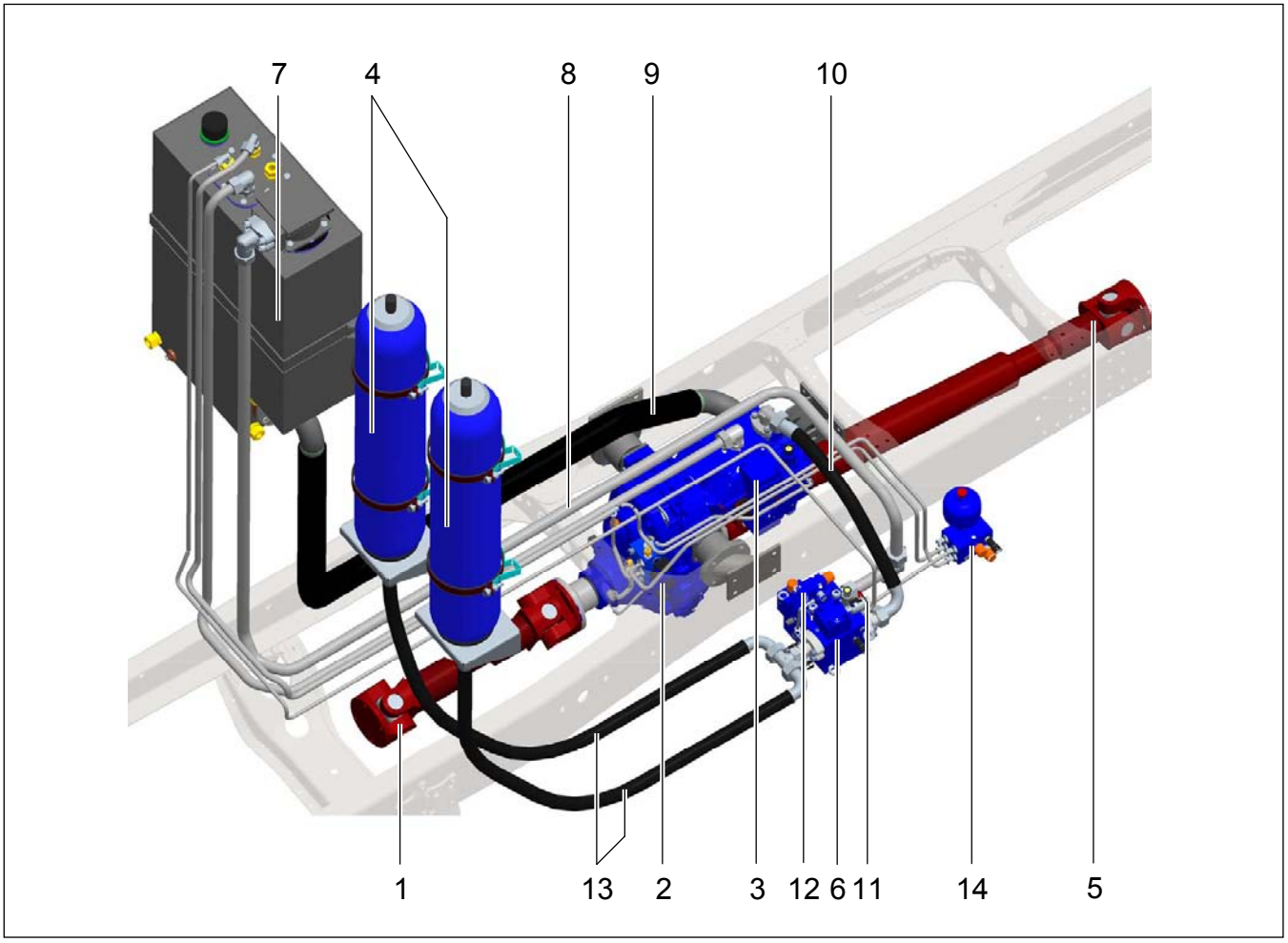

Fig. 3: Examples of installation situation of an HRB from front left

1 Vehicle output drive
2 Gearbox with clutch
3 Axial piston unit
4 Hydro-pneumatic pressure accumulators (high pressure, several in parallel)
5 Differential input
6 HRB manifold
7 Reservoir with filter
8 Reservoir return flow line
9 Axial piston unit low-pressure line
10 Axial piston unit high-pressure line
11 Manual drain valve
12 Accumulator safety valve (optional)
13 High-pressure accumulator line
14 Pilot oil supply manifold

The HRB is designed for use in commercial vehicles or mobile working machines, e.g. refuse trucks. The HRB is installed by the body or chassis manufacturer. Here, the HRB gearbox is installed in the cardan shaft line. The HRB gearbox is secured by a 3-point suspension on the vehicle frame.
The other system components are also secured to the vehicle frame, body, and/or cab.
The components of the system (electric/hydraulic) are designed so that no detrimental effect is to be expected due to water spray.
The system was developed in accordance with the specification defined in the body guidelines of each vehicle manufacturer.

5.3 Operating conditions

To achieve maximum savings, brake applications should be performed in a collective cycle using high HRB switch levels, i.e. high HRB brake performance/ deceleration. Increased use of the service brake decreases the attainable fuel savings. To optimize fuel savings, and intelligent control strategy is employed for the HRB, depending on temperature, mission profile etc. That means, for example, that the HRB may not be able to provide support until the pressure accumulator is completely empty. This is not a malfunction but rather a feature of the control strategy.

Vehicle- or manufacturer-specific explanations can be found in chapter 15.1 "Vehicle- and manufacturer-specific details" on page 103.

5.3.1 Starting/activating for drive mode

The control of the HRB is activated via the ignition key. After the control unit test cycle has been completed, pressure must be built up in the pilot oil supply to actuate the coupling and the axial piston unit, in case the pilot oil pressure in the accumulator is insufficient. This is performed either with an additional HRB pilot oil pump or manually via a connection to the existing body hydraulics. As a rule, it is only necessary to recharge the pilot oil accumulator with an additional HRB pilot oil pump or via the body hydraulics after one or more days of HRB inactivity. The HRB can be deactivated at any time by pressing the button marked "HRB" (the HRB button).

5.3.2 Torque distribution

An important task of the HRB control is to distribute torque between the combustion engine and the HRB. Here, the objective is to make maximum savings possible with the same performance as that achieved without HRB.

5.3.3 Delaying

Between approx. 1 km/h and 50 km/h (the actual values may differ according to the vehicle concerned), the driver can set the HRB braking torque in any of several different levels, similar to when using a retarder. This is automatically activated as soon as the accelerator pedal is released. However, in contrast to a retarder,

a torque is specified that is controlled independently of the current gear engaged in the vehicle gearbox.
The deceleration torque is set by the swivel angle of the axial piston unit and is limited by the current available deceleration torque, which is determined by the current accumulator pressure.
The maximum pressure in the system is limited by a pressure-relief valve. On reaching the maximum pressure – the equivalent of maximally charged hydro-pneumatic pressure accumulators – and continued braking with HRB, no more braking energy is stored. The HRB does, however, continue to supply a delaying torque. In such cases, heat is specifically induced into the hydraulic system via the pressure-relief valve until the maximum operating temperature of the hydraulic oil is reached. To prevent excessive temperatures in the hydraulic system, the HRB braking torque is continually reduced after a few seconds both shortly before the maximum temperature of the hydraulic fluid (75 °C) is reached, and when braking with the accumulators already fully charged.
The temporary inactivity of the HRB is displayed in the vehicle.
The green HRB status indicator/HRB ready goes out in this case. If installed, the yellow HRB status indicator high/low temperature lamp also illuminates.
By actuating the brake pedal, additional braking torque can be generated by the vehicle's service brake system that is independent of the HRB. The HRB does not interfere with the function of the service brake system.

5.3.4 Acceleration

Starting from the driver's command or from the driver's specified torque, the proportions of the drive torque to be supplied are assigned to the combustion engine and the HRB by the HRB control. In doing so, the torque output by the combustion engine is reduced and replaced by the output torque of the axial piston unit, which acts as a motor. The prompt from the driver is transmitted via, for example, the accelerator pedal of the vehicle. The output torque of the hydraulic motor is regulated as requested by the driver, up to the maximum possible output torque, which is dependent on the charge state.

The HRB will not increase the total drive torque of the vehicle – except during switching operations in the vehicle gearbox.

The following factors play a special role in reducing fuel consumption:
a) Acceleration losses are reduced
b) Change in shifting timing (towards lower combustion engine speeds)
The shift points are automatically adjusted by the gearbox shift regulator because the shift points are defined by the load torque and rpm. If the HRB is active, this results in a reduced load and, in turn, a reduced injection amount in the combustion engine. This will then lead to earlier gearbox upshifts.
On vehicles with semi-automatic gearboxes, a launch gear recommendation can be displayed for the driver when the vehicle is at a standstill to help the driver select the best possible launch gear, e.g., via a symbol in the auxiliary display of the body manufacturer.

5.3.5 Normal drive mode

Normal drive mode refers to driving without HRB. This is the case when the hydro-pneumatic pressure accumulator is empty or the maximum speed, approx. 50 km/h (the actual value may vary depending on the vehicle concerned), for operating the HRB is exceeded. In this case, the HRB is separated from the drive train by opening the clutch.

5.3.6 Standstill

The HRB is inactive in standstill (ignition on, motor running). Any accumulator pressure present will be maintained so that the system remains available for launch assistance.

5.3.7 Driving dynamics

The HRB is automatically deactivated during ABS closed loop control. Also, in the critical event of combustion engine torque being reduced by the TCS, the HRB will be temporarily deactivated. These ABS and TCS incidents are detected via the vehicle interface. The green status indicator/HRB ready goes out!
In addition, the same note applies to the HRB that is defined in the vehicle operating instructions for the retarder/engine brake:
"Deactivate the continuous brake (engine brake/retarder) and HRB on slippery road surfaces. The wheels could otherwise lock and the vehicle could start to skid."

5.3.8 Deactivating the HRB

The HRB is deactivated via the ignition switch. If installed, the HRB can also be deactivated via the HRB button. If the system is deactivated using the HRB button any accumulator pressure will be retained. If on the other hand the ignition is deactivated, the high pressure from the hydro-pneumatic pressure accumulator will be relieved within about 5 minutes as a safety precaution.

Note that after an ignition start following the deactivation, the HRB must again be deactivated, since the HRB is automatically active on ignition start.

5.3.9 Heat management

High temperature

To prevent excessively high temperatures in the hydraulic system, the HRB braking torque is continually reduced when the temperature of the hydraulic fluid nears 75 °C. If mounted, the HRB high/low temperature indicator signals this to the driver. The green status indicator/HRB ready goes out in this case.
To avoid frequent excess temperatures, the braking torque of the HRB without cooler is continually relieved after a few seconds with the brakes are applied with the pressure accumulators already charged.

Low temperature

If the hydraulic oil temperature is below the minimum temperature (-10 °C), the system will be inactive. If mounted, the HRB high/low temperature indicator signals this to the driver. The green status indicator/HRB ready goes out in this case. At temperatures below -10 °C, the HRB does not warm up automatically; if the hydraulic circuit of the HRB and body hydraulics are identical, it is possible to warm up the hydraulic oil by actuating the body hydraulics.

Cooling The system is passively cooled by a radiation to the component surfaces, supported by the airflow.

Warm-up While the HRB warms up to operating temperature at hydraulic oil temperatures below -10 °C, there is no acceleration capability available for a short time even though the green status indicator/HRB ready is illuminated.

5.4 Interfaces

The HRB requires electrical energy from and data connections to the vehicle. The exact description of the interfaces can be found in the description of interfaces. The guidelines of the vehicle manufacturer with respect to retrofitting electrical equipment still have to be observed. These are not part of the Rexroth system documentation.

Mechanical interfaces for securing components and for power transmission can be found in the installation drawing and data sheet. Again here, the guidelines of the vehicle manufacturer with respect to the installation of mechanical components must be observed. Corresponding investigations must be performed for the installation in the vehicle.

Unexpected vehicle behavior!

The HRB control is configured for the respective electric interface/architecture (in particular the CAN configuration). In case of changes or interventions, reliable operation of the vehicle is no longer guaranteed.

Do not make any changes to the electrical interfaces/architecture of the vehicle.

⚠ WARNING

Unexpected vehicle behavior!

The HRB control is configured for the respective electric interface/architecture (in particular the CAN configuration). In case of changes or interventions, reliable operation of the vehicle is no longer guaranteed.

- Do not make any changes to the electrical interfaces/architecture of the vehicle.

5.5 Software

5.5.1 Prerequisite

The software is specific to the vehicle and places certain basic prerequisites on the vehicle's electrical interfaces. The specifications can be found in the description of interfaces.

The software can only be replaced and modified by changing the control unit.

5.5.2 Function

HRB The software controls, regulates and monitors the full range of functions of the HRB.

Vehicle interfaces Vehicle interfaces are defined in the description of interfaces.

Refuse trucks (Europe)

On refuse trucks in Europe, the interface to the vehicle that is relevant to the function is the body interface control unit (e.g., the "PSM" on Mercedes-Benz vehicles, or the "KSM" on MAN vehicles) together with the body CAN. As a rule, the interface architecture depends on the vehicle manufacturer and is implemented on the basis of ISO 11992, Part 3 or SAE J1939. The concrete realization by the vehicle manufacturer (e.g. availability of individual signals, etc.) must also be separately examined for each vehicle type in order to guarantee the full functionality and safety of the system.

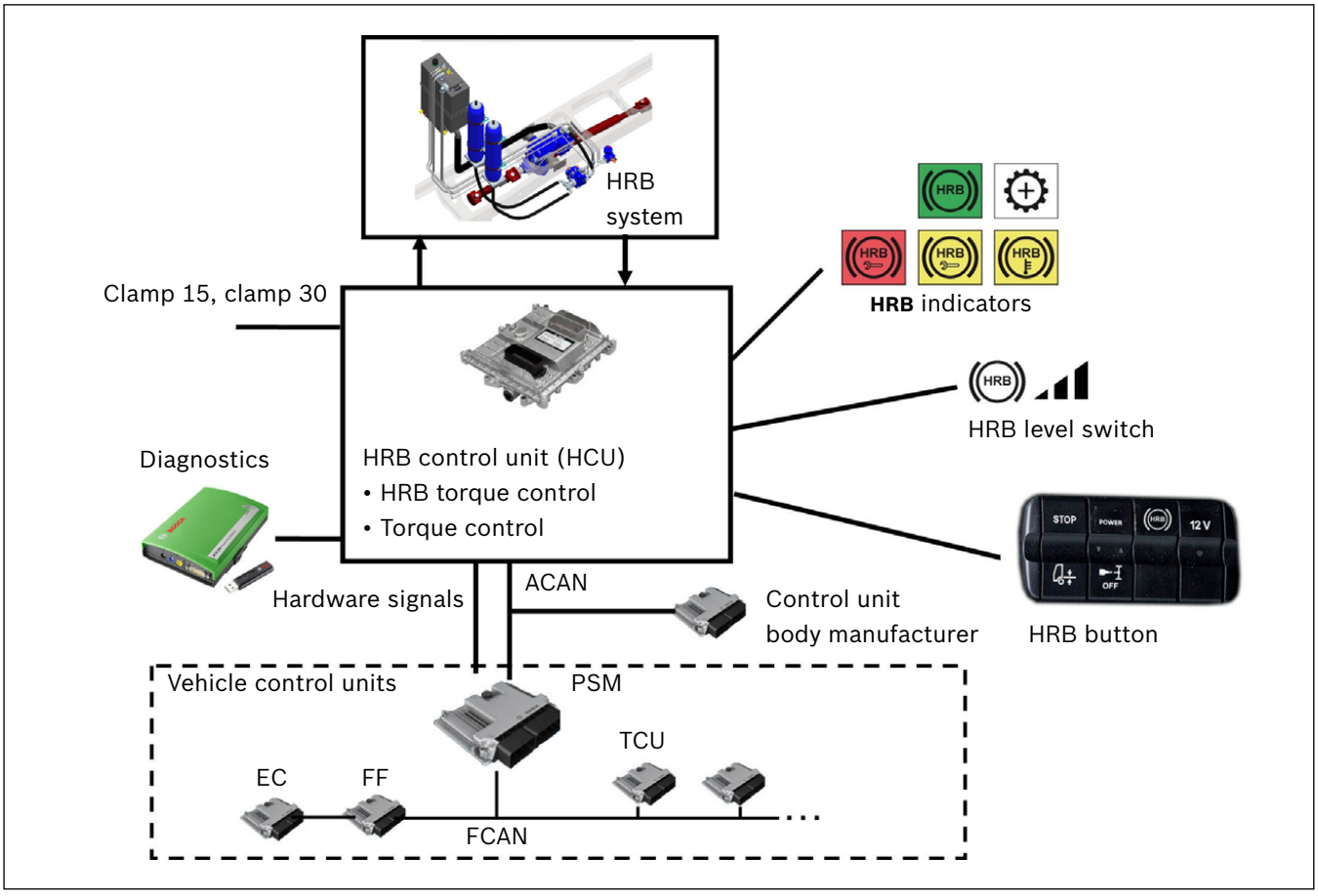

Fig. 4: Electronic interfaces for HRB - example Mercedes-Benz Actros

⚠ WARNING

Unexpected vehicle behavior!

A possible shut-down or the failure of the HRB control unit could cause CAN messages to stop being transmitted or looped through by the HRB control unit.

- A possible shut-down/failure of the HRB control must be taken into account in the safety concept of the body/vehicle manufacturer.

Other vehicle types

Alternatively to the body CAN, the HRB can directly access the vehicle CAN if this is approved by the vehicle manufacturer. Here, the CAN bus must be implemented in accordance with the J1939 SAE standard.

5.5.3 Operation

The software includes the operational scope listed in chapter 9.1 "Control and indicator elements" on page 60.

5.5.4 Diagnostics

For the driver/operator, the HRB indicators are available for simple diagnostics, see chapter 9.1 "Control and indicator elements" on page 60.
More detailed diagnostics for troubleshooting purposes is performed by Bosch Rexroth Service. The address can be found in chapter 10.8 "Spare parts" on page 85.
Information on reading out error codes is provided in chapter 14 "Troubleshooting" on page 89.

5.6 Component overview

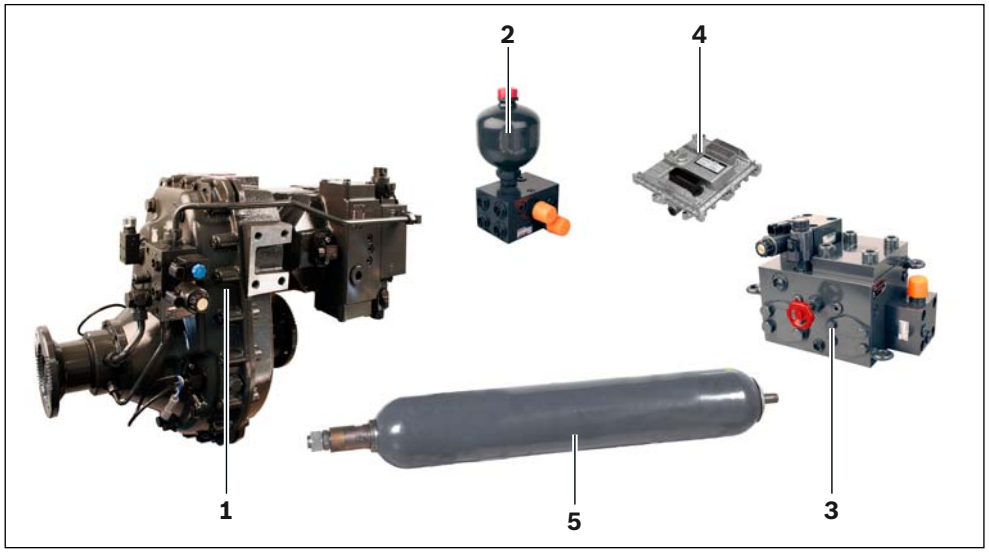

Fig. 5: HRB components

1 Axial piston unit and gearbox assembly
2 Pilot oil supply manifold with pilot oil accumulator
3 HRB manifold
4 HRB control unit (HCU)
5 Hydro-pneumatic pressure accumulator

5.7 Product identification

The system can be identified from the system name plate and the CE plate. The name plate is located on the axial piston unit and gearbox assembly. The following example shows an HRB system name plate:

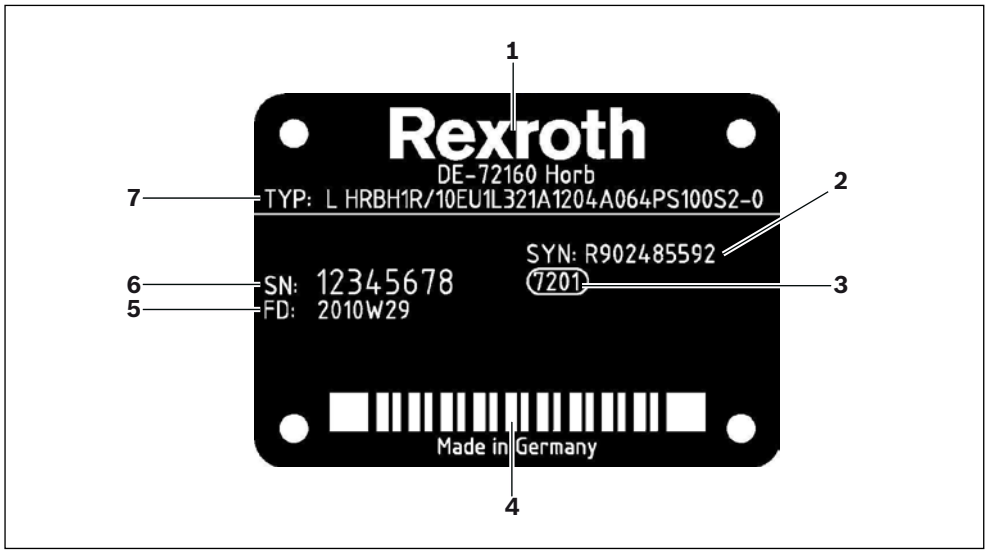

Fig. 6: HRB system name plate

1 Manufacturer
2 HRB system number
3 Internal plant designation
4 Bar code
5 Production date
6 Serial number
7 Ordering code

The CE plate must be attached to a place on the vehicle where it is easily visible.

The following example shows a CE plate:

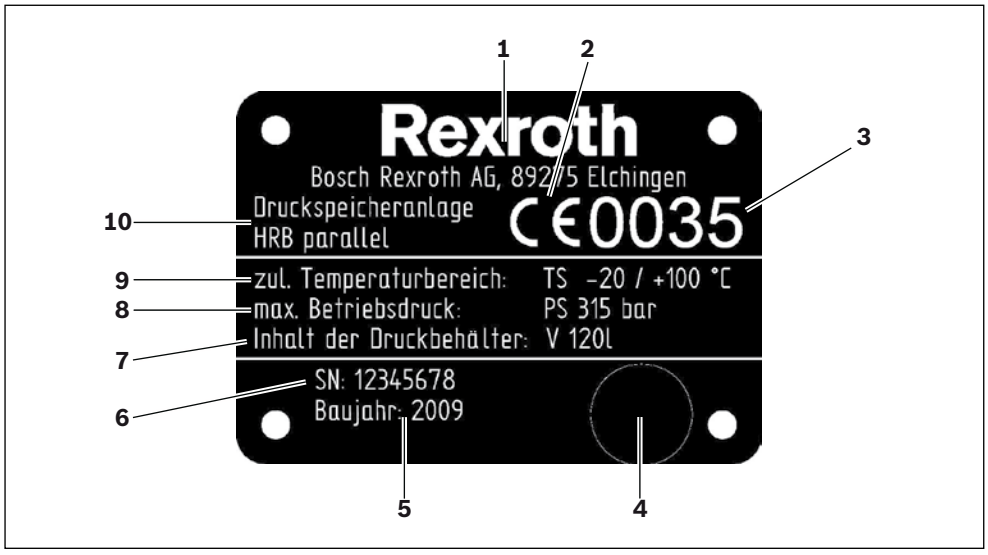

Fig. 7: CE plate

1 Manufacturer
2 CE conformity sign
3 Test station identifier
4 Test stamp
5 Year of manufacture
6 Serial number
7 Pressure accumulator content (volume)
8 Maximum operating pressure
9 Temperature range
10 System designation

6 Transport and storage

- Always observe the required ambient conditions for transport and storage, see chapter 6.3 "Storing HRB components" on page 31.

Notes on unpacking can be found in chapter 7.1 "Unpacking" on page 33.

For information on the correct storage of the HRB components, please also see the data sheet of the HRB.

6.1 Dimensions and weights

Table 6: Dimensions and weights of the HRB components

Components	Weights in kg
Axial piston unit and gearbox assembly	210
Hydro-pneumatic pressure accumulator (32 liters, 1 piece)	85
HRB manifold	48
HRB control unit (HCU)	2
Pilot oil supply manifold including pilot oil accumulator	10
Total weight of HRB main components without hoses and wiring etc. when using two pressure accumulators	approx. 440

The dimensions of the HRB components can be found in the installation drawing. This installation drawing will be sent once only with the initial documentation.

6.2 Transporting the HRB

⚠ CAUTION

Risk of damage!
Attaching the lifting strap to add-on units (e.g., flange of axial piston unit and gearbox assembly, gas valve for hydro-pneumatic pressure accumulator, control valves) can damage the HRB components. The add-on units of the HRB components are not to be used as attachment equipment for transport purposes.

- Only transport the axial piston unit and gearbox assembly by the ring screws as shown in this chapter.
- The gas valve of the hydro-pneumatic pressure accumulator must not be used as attachment equipment and on no account should be damaged.
- Check the attachment equipment that you wish to use for signs of wear or damage before transport.
- Do not fix the lifting strap to the flanges.

The transportation options below exist depending on the weight and duration of the transport:

- Transporting by hand
- Transporting with lifting device (ring screw or lifting strap)
- Transporting with a forklift truck

6.2.1 Transporting by hand

HRB components weighing up to 15 kg may be briefly transported by hand if necessary.

CAUTION! Danger from heavy loads!
There is a danger of health damage when carrying HRB components.

- ▶ Use suitable lifting, placement and relocation equipment.
- ▶ Use your personal protective equipment (e.g. safety glasses, safety gloves, suitable working clothes, safety shoes).

- ▶ Do not transport the HRB components at sensitive add-on parts (e.g., sensors or valves).
- ▶ Carefully place the HRB components on the seating to prevent them from being damaged.

6.2.2 Transporting the axial piston unit and gearbox assembly

For transport, the axial piston unit and gearbox assembly must be connected to a lifting device by the ring screws.

Please note the chain/lifting gear length to ensure that the angle of spread is less than 120°.

Transport with ring screws

For transportation, two ring screws (1) must be screwed into the gear case.

If required, another ring screw can be screwed into the case of the axial piston unit. On the reverse side of the axial piston unit, there are four threaded bores for a third ring screw.

- ▶ For all female threads, use a threaded plug from the same system of units and of the correct size. The thread size is stated in the installation drawing.
- ▶ To do this, screw M16 x 1.5-C15E (fine-thread) ring screws (**1**) according to DIN 580 completely into the female threads located in the case of the axial piston unit and gearbox assembly.
- ▶ Make sure that the ring screw is adequately dimensioned for the weight of axial piston unit and gearbox assembly.

The axial piston unit and gearbox assembly can be lifted using the screwed-in ring screws as shown in Fig. 8.

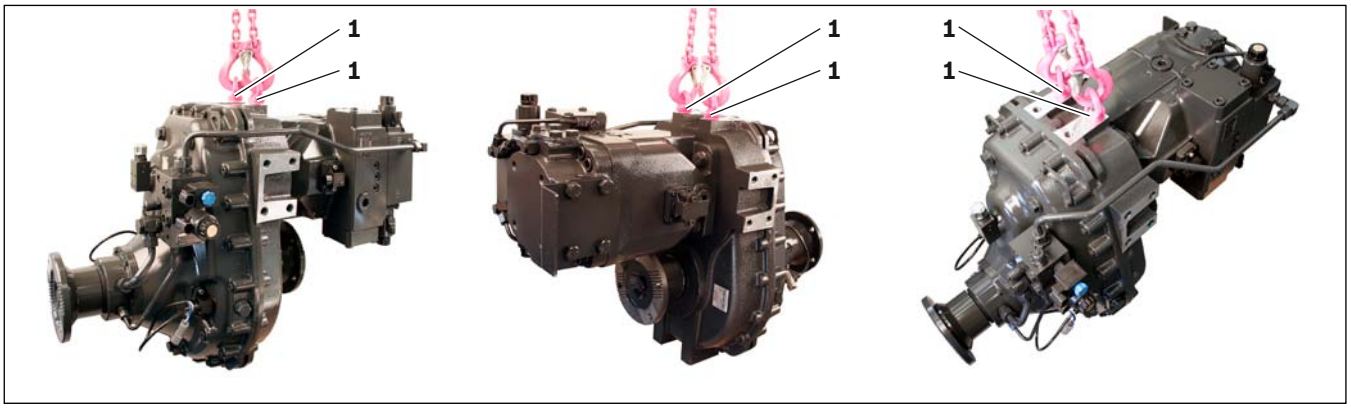

Fig. 8: Ring screws on the gear case of the axial piston unit and gearbox assembly

6.2.3 Transporting the HRB manifold

The HRB manifold is delivered with the ring screws (**1**) pre-installed. Use these ring screws for transporting the HRB manifold. Join two opposite ring screws for safe transport with a lifting device. Use a chain or another suitable form of lifting gear.

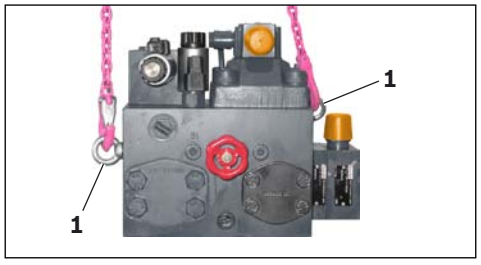

Fig. 9: Transporting the HRB manifold

Please note the chain/lifting gear length to ensure that the angle of spread is less than 120°.

6.2.4 Transporting the pressure accumulator

A lifting strap can be used for transporting the hydro-pneumatic pressure accumulator. This is to be connected to a lifting device.

Transport with lifting strap

The following must be noted when transporting with a lifting strap:

WARNING! Risk of injury!
During transport with a lifting strap, the pressure accumulator could tip or slip out of the loop, causing injury.

- Hold the pressure accumulator tight with your hands during transport to prevent it from tipping/slipping out of the loop.
- Use the widest possible lifting strap.

- Place the lifting strap around the pressure accumulator so that it is not routed over add-on units and is not caught on add-on units.

Fig. 10: Transporting the pressure accumulator with lifting strap

6.3 Storing HRB components

Requirement

- The storage areas must be free from corrosive materials and gases.
- To prevent damage to the seals, ozone-forming equipment (e.g. mercury-vapor lamps, high voltage equipment, electric motors, sources of electrical sparks or electrical discharges) must not be operated in storage areas.
- The storage areas must be dry.
- Ideal storage temperature: +5 °C to +20 °C.
- Minimum storage temperature: -40 °C.
- Maximum storage temperature: +60 °C.
- Avoid high light irradiation (e.g. bright windows or direct fluorescent lighting).
- Store the HRB components shock-proof, do not stack them.
- Do not store the HRB components on flanges or add-on parts, e.g., sensors or valves.
- HRB control units must be stored with an average relative humidity of 60 % and at a temperature between -10 °C and +30 °C. A storage temperature range of -20 °C to +40 °C is permissible for a short period of 100 h. After a storage time of more than 5 years, the HRB control unit must be checked by the manufacturer before use. If the HRB control unit is dropped, continued use is not permissible because unseen damage may affect its reliability.
- For further storage conditions, see tTable 7.

▶ Check the HRB components monthly to ensure proper storage.

After delivery

The HRB components are provided ex-works with corrosion protection packaging (corrosion protection film).
In Table 7 you will find the maximum permissible storage times for the originally packaged HRB components.

Table 7: Storage time with factory corrosion protection

Storage conditions	Standard corrosion protection
Closed, dry room, uniform temperature between +5 °C and +20 °C. Undamaged and closed corrosion protection film.	Maximum 12 months

Entitlement to warranty will be rendered void if the requirements and storage conditions are not adhered to or after expiration of the maximum storage time (see Table 7).

Procedure after expiry of the maximum storage time:

1. Check all HRB components for damage and corrosion prior to installation.
2. Consult your Bosch Rexroth Service partner when storage times have expired to ensure that the HRB components remain fully functional.
3. If a storage time of 24 months is exceeded, the shaft seal rings of the axial piston unit and gearbox assembly must be replaced.

After expiration of the maximum storage time, we recommend that you have the HRB components inspected by your responsible Bosch Rexroth Service partner.

Should you have any questions about repairs or spare parts, please contact your responsible Bosch Rexroth Service partner. Please refer to chapter 10.8 "Spare parts" on page 85.

7 Installation

Prior to installation, the following documents must be ready at hand:
- Technical documents, including installation drawings of the HRB components, hydraulic and electric circuit diagram(s)
- Order confirmation (contains the order-related technical data of the HRB)

7.1 Unpacking

The HRB components are delivered in a corrosion protection film made of polyethylene material (PE).

CAUTION! Danger from parts falling out!
If the packaging is not opened correctly, parts may fall out and damage the parts or even cause injuries!
- ▶ Place the packaging on a flat and solid underground.
- ▶ Only open the packaging from the top.

- ▶ Remove the packaging from the HRB components.
- ▶ Check the HRB components for transport damages and completeness, see chapter 4 "Delivery contents" on page 18.
- ▶ Dispose of the packaging according to the national regulations of your country.

7.2 Installation conditions

Installation position and location of the axial piston unit and gearbox assembly of the HRB play a decisive role in determining the procedure to be applied for installation and commissioning (e.g., when filling and air bleeding the axial piston unit and gearbox assembly).
Note the specified installation position, which is shown on the respective installation drawing and comply with the notes on the data sheet.
- ▶ HRB components must not be installed close to hot vehicle components!
- ▶ The HRB components must be installed in accordance with the relevant vehicle manufacturer's guidelines.
- ▶ Make certain that the case of the axial piston unit and gearbox assembly is air bled and filled with hydraulic fluid and lubricating oil during commissioning. This is also to be observed following relatively long standstill periods as the hydraulically operated parts of the axial piston unit and gearbox assembly may empty via the hydraulic lines.
- ▶ To achieve favorable noise values, isolate all connecting lines and the HRB components from all vibration-capable components (e.g., the chassis) using elastic elements.
- ▶ Make sure that the suction pressure does not drop below a minimum value of 0.8 bar absolute for the axial piston unit and gearbox assembly in all installation positions and locations in pump mode and on cold start and that the back pressure does not fall below a minimum value of 1.1 bar absolute at port **S_P** in motor mode, see Fig. 11.

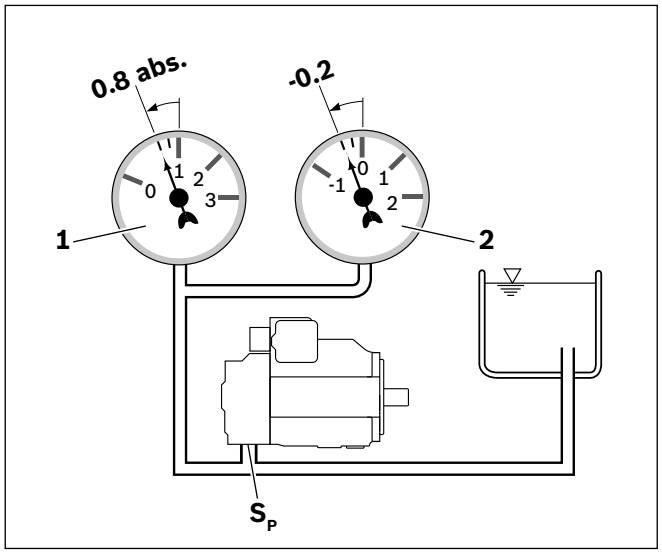

Fig. 11: Suction pressure

1 Absolute pressure gauge
2 Standard pressure gauge (relative)

- Make sure that the working environment at the installation site is fully free of dust and foreign substances. HRB components must be in a clean condition when they are installed. Contamination of the hydraulic fluid or of the lubricating oil can have a considerable impact on the service life and function of the HRB.
- Use lint-free cloths for cleaning.
- Use suitable mild detergents to remove lubricating oil and other difficult-to-remove contamination. Cleaning agents must not enter the hydraulic system.

Observe all relevant standards, directives, legal requirements and other documents relevant to your application case; for refuse trucks, e.g., DIN EN 1501. The implementation is the responsibility of the body or vehicle manufacturer. Such documents are subject to changes and additions at any time. The standards and documents listed in the documentation of the HRB therefore make no claim for completeness and/or up-to-dateness! Observe the notes and document references in the HRB documentation as well as special requirements regarding the design of the used hydraulic components (such as hoses and connections) and for the protection of operators/persons.

7.3 Installation positions

Three installation positions are permissible for the HRB axial piston unit and gearbox assembly:

- not rotated (fig. 12)
- rotated 90° counter-clockwise (fig. 13)
- rotated 90° clockwise (fig. 14)

Gear bleeding is performed automatically via a separate air bleed vent mounted on the gear case. Depending on the installation position, the bleed valve will vary in relation to the gearbox. The orientation will always be the same in relation to the vehicle axles. For this reason, only one specific installation position is permissible for each axial piston unit and gearbox assembly (see the relevant installation drawing).

Installation position not rotated, plan view

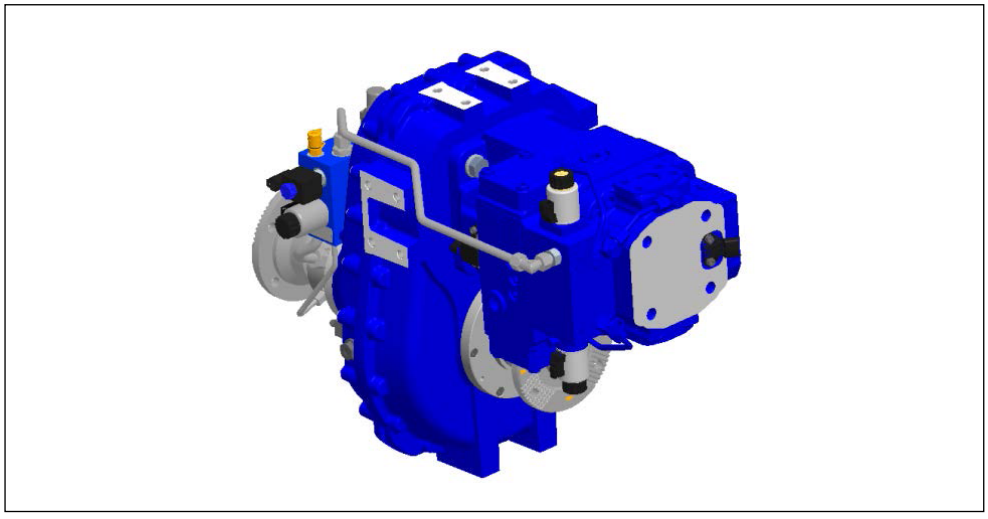

Fig. 12: HRB installation position not rotated, plan view

Table 8: Filling and air bleeding of axial piston unit and gearbox assembly for installation position "not rotated"

Components	Air bleed	Filling	Oil drain	Oil level check	Oil type
Axial piston unit	$K2_P$[1)]	$K2_P$[1)]	$K1_P$[1)]	Axial piston unit must be completely filled via the filling port	HLP 32 Other fluids only upon request[2)]
Gearbox	–	G1/G3/G4[1)]	G2[1)]	G3[1)]	See data sheet

[1)] Port is marked on the axial piston unit and gearbox assembly.

[2)] Depending on climatic conditions, other hydraulic oils may also be used upon consultation with Bosch Rexroth.

Installation position rotated 90° counter-clockwise, plan view

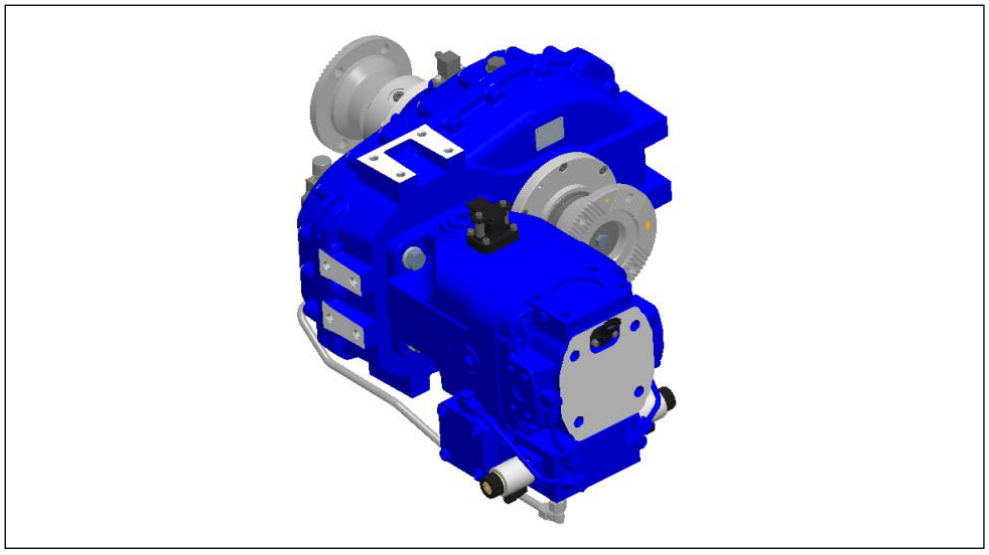

Fig. 13: HRB installation position rotated counter-clockwise, plan view

Table 9: Filling and air bleeding of axial piston unit and gearbox assembly for installation position "rotated 90° counter-clockwise"

Components	Air bleed	Filling	Oil drain	Oil level check	Oil type
Axial piston unit	T_P [1]	T_P [1]	R(L)1_P [1]	Axial piston unit must be completely filled via the filling port	HLP 32 Other fluids only upon request [2]
Gearbox	–	G2/G3/G4/ G5 [1]	G1 [1]	G6 [1]	See data sheet

[1] Port is marked on the axial piston unit and gearbox assembly.

[2] Depending on climatic conditions, other hydraulic oils may also be used upon consultation with Bosch Rexroth.

Installation position rotated to right by 90°, view from above

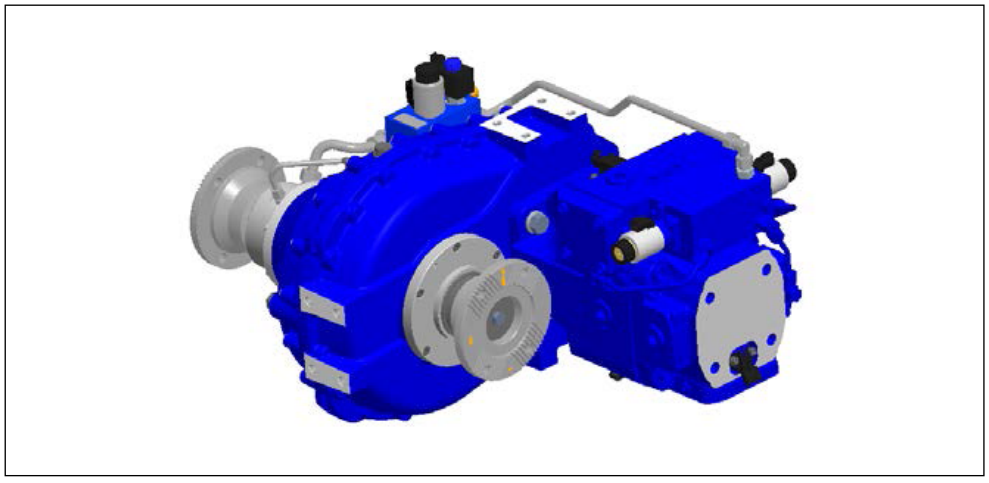

Fig. 14: HRB installation position rotated 90° clockwise, plan view

Table 10: Filling and air bleeding of axial piston unit and gearbox assembly for installation position "rotated 90° clockwise"

Components	Air bleed	Filling	Oil drain	Oil level check	Oil type
Axial piston unit	R(L)1_P [1]	R(L)1_P [1]	T_P [1]	Axial piston unit must be completely filled via the filling port	HLP32 Other fluids only upon request [2]
Gearbox	–	G1/G2/G6 [1]	G4 [1]	G5 [1]	See data sheet

[1] Port is marked on the axial piston unit and gearbox assembly.

[2] Depending on climatic conditions, other hydraulic oils may also be used upon consultation with Bosch Rexroth.

7.4 Installing the HRB

7.4.1 Preparation

1. Compare the material number, designation (ordering code) and configuration of the intended vehicle with the specifications in the order confirmation.

If the material numbers of the components do not correspond to those in the order confirmation, contact Bosch Rexroth Service for clarification, see chapter 10.8 "Spare parts" on page 85 for address.

2. Secure the vehicle (apply the handbrake, use chocks and remove the ignition key).
3. Disconnect the vehicle battery in accordance with the vehicle manufacturer's instructions.

7.4.2 Dimensions

The installation locations for the HRB manifold, pilot oil supply, hydro-pneumatic pressure accumulator and HRB control unit depend on the vehicle type and vehicle body. The installation drawing contains dimensions for all ports for HRB components and the permissible securing options. Also observe the manuals provided by the manufacturers of the other hydraulic components when selecting the required tools.

7.4.3 General instructions

- The axial piston unit and gearbox assembly can be installed in the vehicle from above using a lifting device or from below from an installation pit.
- During installation of the axial piston unit and gearbox assembly when using installation pits, lifting devices with large travel lengths may be necessary. Independent of this, it is recommended that a sufficiently dimensioned service hatch be provided in the assembly to facilitate access to the installed axial piston unit and gearbox assembly. It should be possible to remove the axial piston unit and gearbox assembly upward through this service hatch with a crane or similar lifting device.
- The HRB manifold is supplied with ring screws installed to make it easier to transport and position on the vehicle. If the ring screws are removed, the surfaces of the HRB manifold that were previously covered by the ring screws and which are now unprotected should be painted for reasons of corrosion protection. Also observe the notes for improving the corrosion properties in section "Improving corrosion characteristics" on page 50. Other unpainted surfaces of the HRB components and sensor (e.g., ventilation filter, name and identification plates and notices, red protective caps, manual drain valve, etc.) are not to be painted in the event of subsequent painting and must not generally be painted over.
- The HRB components must be secured to the vehicle frame and/or body using special brackets (see installation drawing and specifications in the data sheet). These brackets are not part of the delivery contents of the HRB.
- HRB components must not be installed close to hot vehicle components!
- The HRB components must be installed in accordance with the relevant vehicle manufacturer's guidelines.
- The HRB components must be installed so that all filters, ports and sensors are easily accessible. For servicing and maintenance work, it may be necessary to replace filters/filter cartridges, sensors, actuators and lines.

- Take constructive measures to protect exposed components of the HRB (hoses, cables, connectors and sensors, etc.) from damage that could result from whirled-up contaminants depending on the respective installation position (e.g., stone impacts).

▶ Please note also the specifications for installation, connecting and integrating the HRB stated in the data sheet.

7.4.4 Installing the HRB components

A detailed description of how to install the HRB components is provided in the following:

Installing the axial piston unit and gearbox assembly

1. Remove the original cardan shaft in accordance with the manufacturer's instructions.
2. Install the brackets for the axial piston unit and gearbox assembly on the vehicle frame.

The brackets for the axial piston unit and gearbox assembly are not included in the delivery contents of the HRB. Information about permissible securing options and external forces can be found in the installation drawing and in the data sheet.

3. Make certain that the installation location is clean and free from dirt and contaminants.
4. Position the axial piston unit and gearbox assembly in the required installation position with a suitable lifting device and attachment equipment, see chapter 7.3 "Installation positions" on page 35.

Make sure that the gauge port on the axial piston unit and gearbox assembly (see Fig. 31 on page 67), which is used for draining/relieving pressure in the pilot oil accumulator, is easily accessible.

5. Secure the axial piston unit and gearbox assembly by the harness and tighten the screw connections.
6. Install the new cardan shafts in accordance with the instructions of the cardan shaft manufacturer.

The new, shortened cardan shafts are not included in the delivery contents of the HRB (design as per vehicle manufacturer specifications).

Installing the control and indicator elements

1. Now install the additional control and indicator elements to the vehicle.

The additional control and indicator elements are not in the delivery contents of the HRB.

Installing the HRB control unit

1. Now install the HRB control unit to the vehicle in accordance with the installation drawing.

Please note that the HRB control unit cannot be operated in standing or permanently running water. In addition, water ingress via the wiring harness must also be prevented. Further information can be found on the installation drawing.

2. Make sure that the HRB control unit does not contact the vehicle (installation case).
3. The HRB control unit must be fixed at eight points. Bosch Rexroth recommends the use of a damper.
4. First tighten the mounting bolts by hand.
5. Tighten the mounting bolts with a tightening torque of 10^{+2} Nm in bolt sequence 1 to 8.
6. Make sure that the cable harnesses are mechanically absorbed on the same vibration plane as the HRB control unit at a maximum distance of 150 mm after the cable outlet.

Installing the hydro-pneumatic pressure accumulators

WARNING! Risk of toxication and suffocation!
The emission of nitrogen in closed or insufficiently ventilated rooms may lead to fatal or hazardous concentrations of nitrogen in the air.

- The hydro-pneumatic pressure accumulators must be positioned so that no high concentrations of nitrogen may form in the passenger compartment.

1. Install the brackets for the hydro-pneumatic pressure accumulator to the vehicle frame and/or body.
2. Select the installation location for the hydro-pneumatic pressure accumulator as close as possible to the axial piston unit and gearbox assembly.

For optimal operation of the hydro-pneumatic pressure accumulator, the climatic conditions should be taken into account for installation.
The preferred installation position of the hydro-pneumatic pressure accumulator is vertical, with gas valve facing upward. In addition, installation positions between vertical (gas valve facing upward) and horizontal (minimum angle 7°, gas valve facing upward) are possible.

3. Protect the hydro-pneumatic pressure accumulator against heat sources, electrical and magnetic fields, lightning, moisture and other negative ambient conditions.

The brackets for the hydro-pneumatic pressure accumulator are not included in the delivery contents of the HRB. Information about the permissible securing options can be found in the data sheet.

4. Install the hydro-pneumatic pressure accumulator so that it is unable to make any uncontrolled movement and so that no external forces can act on it.
5. When installing the hydro-pneumatic pressure accumulator, make sure that all markings and labels are easily visible and readable.
6. Leave at least 200 mm of space in the longitudinal direction to the gas valves of the hydro-pneumatic pressure accumulator for testing and filling equipment.

Installing the HRB manifold and pilot oil supply manifold

1. Install the brackets for the HRB manifold and the pilot oil supply manifold to the vehicle frame. When doing so, comply with the instructions of the vehicle manufacturer and with the information given in the installation drawing.

The brackets for the HRB manifold and the pilot oil supply manifold are not included in the delivery contents of the HRB. Information about the permissible securing options can be found in the data sheet.

2. Install the HRB manifold/pilot oil supply manifold at the specified installation location.

Position the HRB manifold so that the manual drain valve (see Fig. 16 on page 42) is easily accessible at all times. For reasons of corrosion protection, make sure that the pilot oil supply manifold is installed in such a way that the pilot oil accumulator points vertically up. Otherwise, investigations are to be performed into the corrosion behavior.

According to the national regulations, a note (e.g., pictogram) is to be attached to the manual drain valve that provides information on function and operation.

3. Now route the hydraulic lines and hoses and connect the HRB components as described in the installation drawings and the hydraulic circuit diagram, see also chapter 7.4.7 "Hydraulically connecting the HRB" on page 42.

7.4.5 Installing the pressure accumulator temperature sensor

1. Position the temperature sensor for the pressure accumulator half way along the pressure accumulator as shown in Fig. 15. Make sure that the contact surface is against the shell of the pressure accumulator. If two pressure accumulators are fitted, it is important for the sensor to be located between the two pressure accumulators. Protect the sensor from sunlight as much as possible.
2. Secure the sensor with a suitable wire tie.
3. To relieve tension, secure the sensor wire about 10 cm underneath the sensor position (e.g., with plastic cable ties).

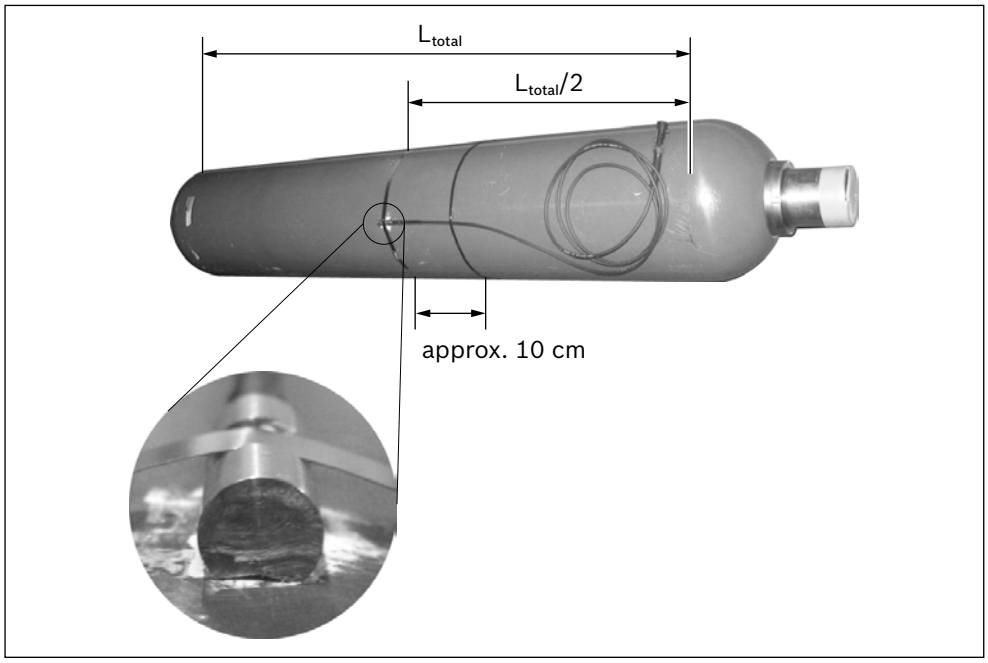

Fig. 15: Securing the pressure accumulator temperature sensor

7.4.6 Completing installation

1. Remove any mounted transport screws.

CAUTION! Operation with protective plug!
Operating the axial piston unit and gearbox assembly with protective plugs could cause injury or damage to the axial piston unit and gearbox assembly.

- Before commissioning, remove all protective plugs and replace them with suitable, pressure-proof, metal threaded plugs.

2. Remove the transport protection.
   The axial piston unit and gearbox assembly is delivered with protective covers and protective plugs. They are not pressure-resistant, therefore they have to be removed prior to connection. Use a suitable tool for this to prevent damage to the sealing and functional surfaces. If sealing or functional surfaces are damaged, contact your responsible Bosch Rexroth Service partner or the service department of the manufacturer's plant for the HRB components.

Ports intended for connecting lines are covered by protective plugs or threaded plugs, which serve as transport protection. All ports required for functional operation must be connected (see Table 11 "Hydraulic ports HRB" on page 49). If this requirement is disregarded, malfunction or damage may result. If a port is not connected, it must be plugged with a threaded plug because protective plugs are not pressure-resistant.

7.4.7 Hydraulically connecting the HRB

DANGER

Risk of personal injury and damage to equipment!

If installation work is performed on a hydraulic system or pressure accumulator that has not been depressurized, and/or in the event of damage caused by an accident, there is an increased risk of injury from the pressure accumulator bursting or from hydraulic fluid escaping under high pressure.

- Before hydraulically connecting the HRB, the manual drain valve (**1**) for the hydro-pneumatic pressure accumulator in the HRB manifold must be opened (see Fig. 16). Open the valve slowly!

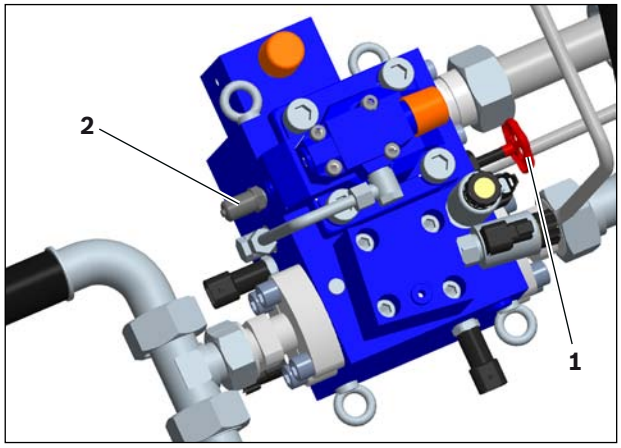

Fig. 16: HRB manifold with manual drain valve

1 Drain valve

2 Gauge port $HD1_v$

CAUTION

Risk of damage to the HRB components!

When installing hydraulic lines and hoses under mechanical stress, they are exposed to additional mechanical forces during operation which reduce the service life of the HRB components and of the entire vehicle.

- Install hydraulic lines and hoses without mechanical stress.

Damage to hydraulic lines system and oil leaks!

Rigid piping between HRB components that can move relative to each other could develop leaks or burst. Make sure that relative movement is possible even between HRB components that are securely fixed to the vehicle frame at different positions.

- Connect the HRB components that can move relative to each other with flexible hydraulic hoses that allow for motion compensation.

NOTE

Insufficient suction pressure!
For axial piston units and gearbox assemblies, a minimum permissible suction pressure in pump mode and a minimum permissible back pressure in motor mode at port **S_P** are generally specified for all installation positions, see chapter 7.2 "Installation conditions" on page 33. If the pressure at port **S_P** falls below the specified values, damage could occur that could lead to the destruction of the axial piston units and gearbox assemblies!

- Make sure that the necessary suction pressure in pump mode and the necessary back pressure in motor mode are maintained. This is influenced by:
  - the piping (e.g. suction cross-section, pipe diameter, length of suction line)
  - the position of the reservoir

The body or vehicle manufacturer is responsible for designing the lines. The HRB components must, if necessary, be connected to the rest of the hydraulic system in accordance with the hydraulic circuit diagram of the body or vehicle manufacturer and in accordance with the HRB hydraulic circuit diagram.
The ports and fastening threads are designed for the maximum pressure specified in the data sheet. The body or vehicle manufacturer must ensure that the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors. High-pressure components that could cause injury to persons on account of their position are to be suitably shielded (e.g. with protective hoses or screening plates).

Connect only hydraulic lines that are appropriate for the ports of the HRB components (pressure level, size, system of units).

Notes on routing the lines

Observe the following notes when routing the suction, pressure and reservoir lines.

- Lines and hoses must be installed without pre-charge pressure so that no further mechanical forces are applied during operation that will reduce the service life of the axial piston unit and gearbox assembly and, if applicable, the vehicle.
- Use suitable seals as sealing material.
- Suction line (pipe or hose)
  - The suction line should be as short and straight as possible.
  - Measure the line cross section of the suction line so that the pressure at the suction port does not drop below the minimum permissible pressure. Make sure that the maximum suction pressure is not exceeded (e.g. when pre-filling).
  - Make sure the connections and connecting elements are air-tight.
  - The hose must be pressure-resistant, also for external air pressure.

- Pressure line
  - For the pressure lines, use only pipes, hoses and connecting elements rated for the operating pressure range specified in data sheet RE 94850 (see Table 11).
- Drain line
  - Always route the reservoir lines so that the case is constantly filled with hydraulic fluid and to ensure that no air gets through the shaft seal even during extended standstill periods.
  - The case internal pressure must not exceed the limit values listed for the axial piston unit and gearbox assembly in the data sheet under any operating conditions.
  - The reservoir line joint in the reservoir must always be below the minimum fluid level under all conditions (see chapter 7.3"Installation positions" on page 35).

CAUTION! Fire hazard!
There is a risk of fire if oil lines are routed close to high-temperature components.
- ▶ Do not route the oil lines close to high-temperature components (e.g. exhaust system). If necessary fit screening plates.

- Make sure that no oil lines are installed close to ignition sources, the exhaust system or screening plates.
- If the axial piston unit and gearbox assembly is equipped with installed screw fittings, these must not be unscrewed. Screw the threaded plug of the fitting directly into the installed screw fitting.

Risk of mix-ups with threaded connections

The HRB components are used in regions using the metric measuring system, in regions using the Anglo-American (imperial) measuring system and in regions using the Japanese (JIS – **J**apan **I**ndustrial **S**tandard) measuring system. Moreover, various kinds of seal are used.
The system of units, the kind of seal and the size of female thread and threaded plugs (e.g., locking screw) must all match.
Due to the limited options for visually detecting differences, there is a risk of mix-ups.

WARNING! Leaking or popped-out threaded plugs!
If a threaded plug which is of a different measurement system, kind of seal and size with respect to the female thread is pressurized, the threaded plug may loosen itself or even be ejected from the hole in a projectile-like manner. This can result in serious injury and damage to equipment. Hydraulic fluid or lubricating oil could escape from this leakage point.
- ▶ Use the drawings (installation drawing) to determine the required threaded plug for each fitting.
- ▶ Make certain that there are no mix-ups when installing fittings, mounting bolts and threaded plugs.
- ▶ For all female threads, use a threaded plug from the same system of units and of the correct size.

Port overview

In the following figures and tables, the ports to the HRB components are illustrated and specified.

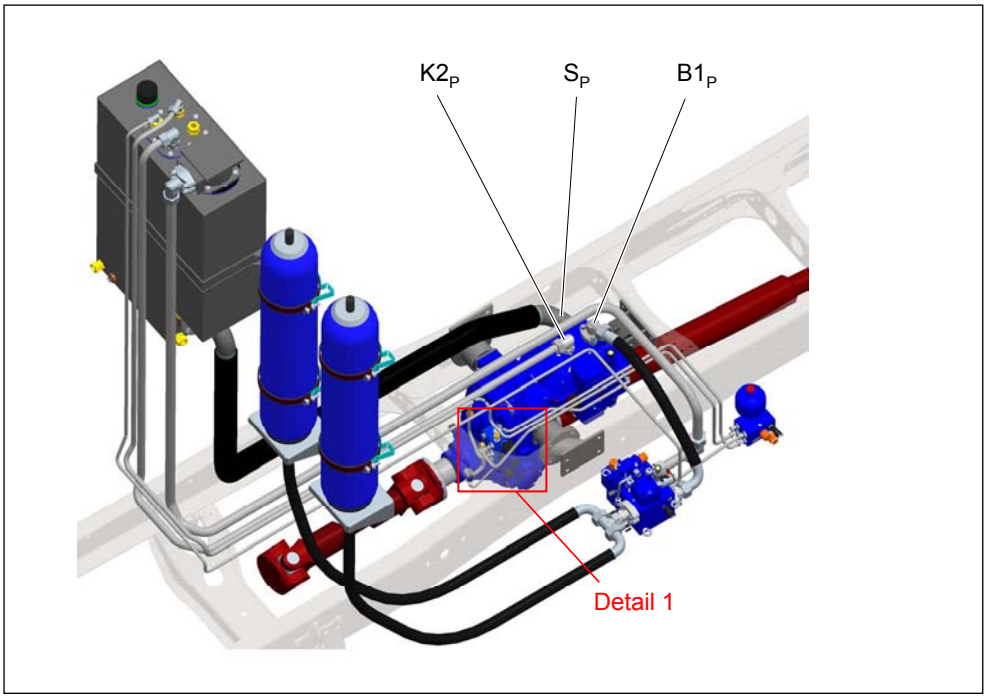

Fig. 17: Port overview of HRB components

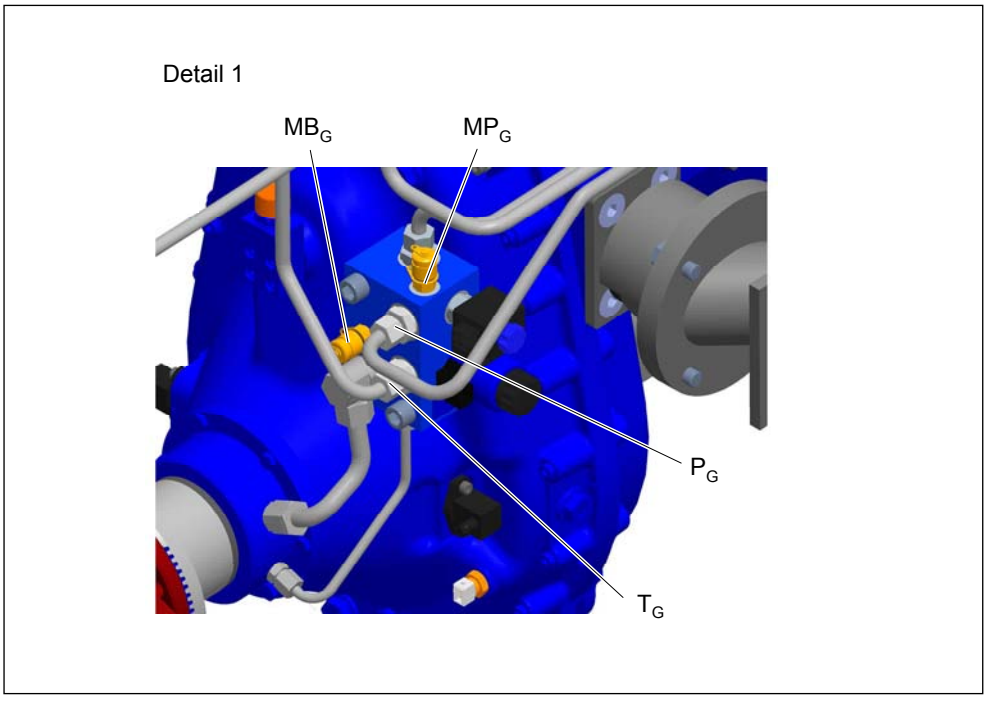

Fig. 18: Port overview - detail 1

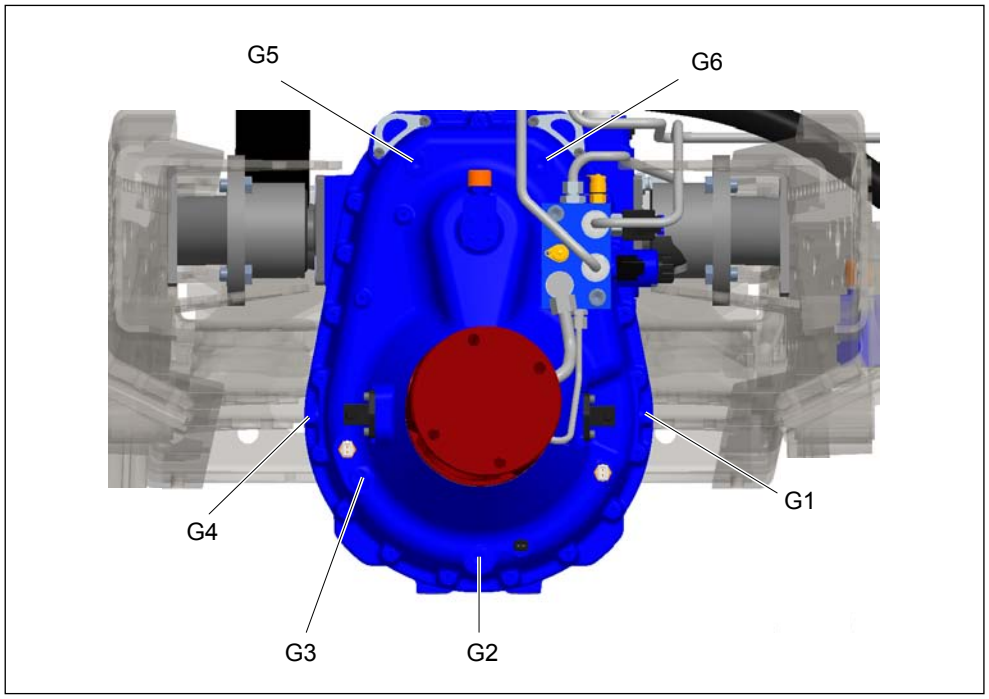

Fig. 19: Port overview of HRB components

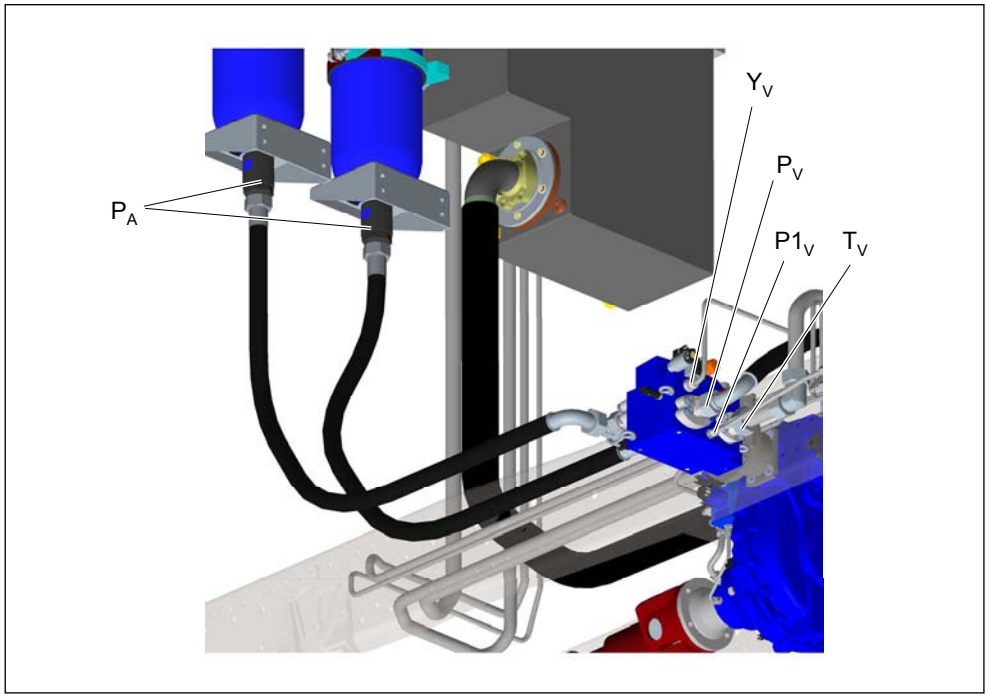

Fig. 20: Port overview of HRB components

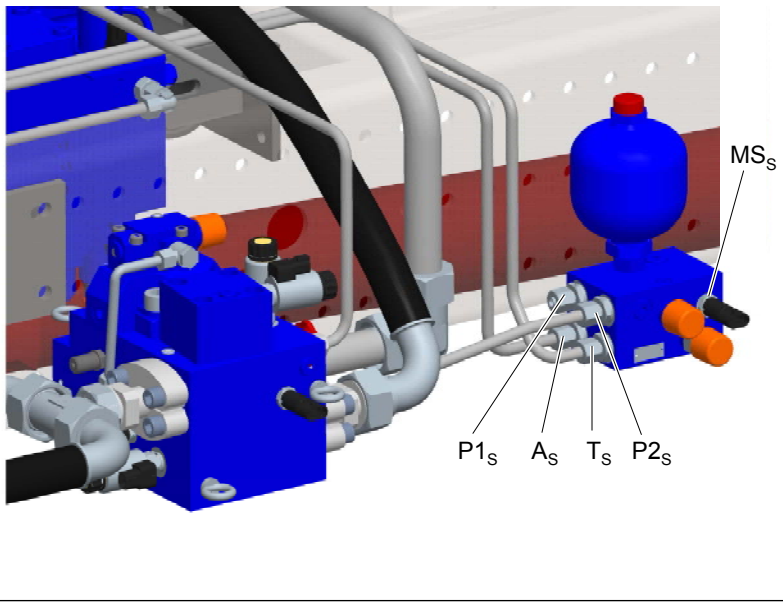

Fig. 21: Port overview of HRB components

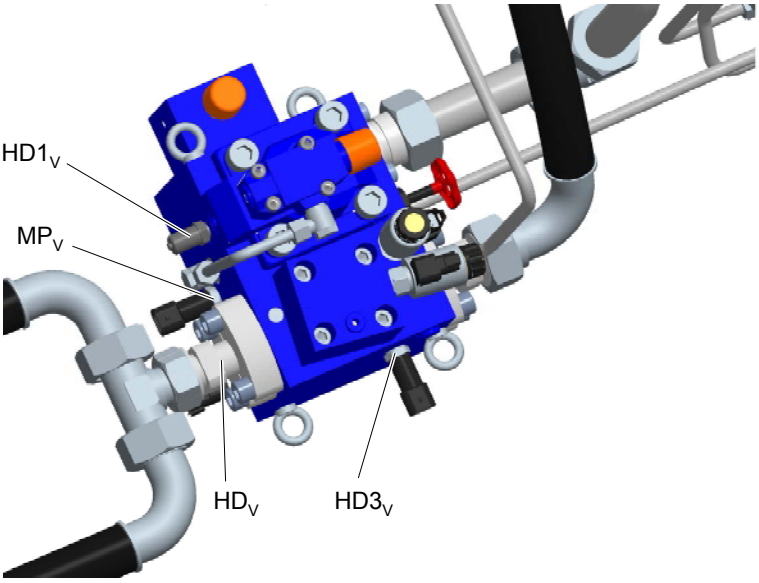

Fig. 22: Port overview of HRB components

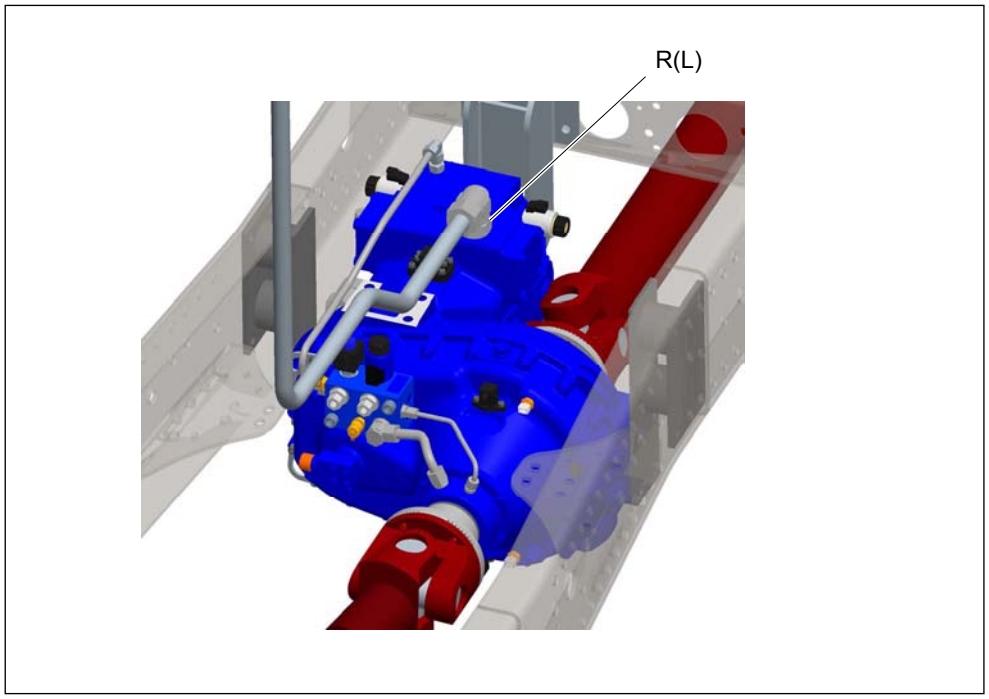

Fig. 23: Case drain port on axial piston unit, installation position rotated 90° clockwise

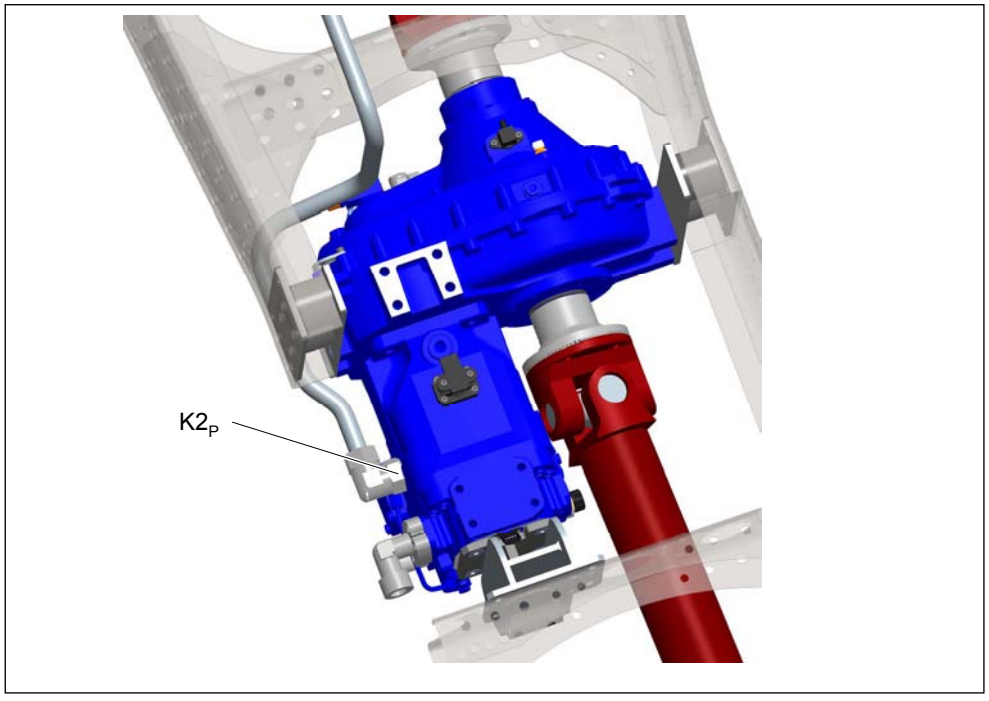

Fig. 24: Case drain port on axial piston unit, installation position rotated 90° counter-clockwise

Note the reservoir position axial piston unit and gearbox assembly is turned 90° counter-clockwise. It must be guaranteed that the minimum oil level in the reservoir is always higher than the highest point of the axial piston unit. This will prevent the axial piston unit from being drained through the case drain line while at a standstill (port **K2$_P$**).

Table 11: Hydraulic ports HRB

Designation	Function
A_S	Pilot oil port on pilot oil supply manifold
$B1_P$	Pressure port on axial piston unit
G1 to G6	Oil inlet/outlet and oil level (see chapter 7.3 "Installation positions" on page 35)
$HD1_V$	High-pressure gaugeport on HRB manifold
$HD3_V$	High-pressure gauge port on HRB manifold
HD_V	Reservoir port on HRB manifold
$K2_P$	Case drain port on axial piston unit, installation position rotated 0°/90° counter-clockwise
MB_G	Clutch line gauge port in gearbox control block
MP_G	Pilot oil line gauge port in gearbox control block
MP_V	Pressure line gauge port on HRB manifold
MS_S	Pilot oil line gauge port on pilot oil supply manifold
$P1_S$	Pressure port 1 on pilot oil supply manifold
$P1_V$	Pilot oil port on HRB manifold
$P2_S$	Pressure port 2 on pilot oil supply manifold
P_A	Pressure accumulator oil port
P_E	Pressure port on external pilot oil supply
P_G	Pressure port on gearbox control block
P_{SV}	Pressure port on pressure sequence valve block
P_V	HRB manifold pressure port
$R(L)1_P$	Case drain port on axial piston unit, installation position rotated 90° clockwise
S_E	Suction port for external pilot oil supply
S_P	Axial piston unit suction port
T_G	Reservoir port on gearbox control block
T_S	Case drain port on pilot oil supply manifold
T_{SV}	Reservoir port on pressure sequence valve block
T_V	HRB manifold reservoir port
Y_V	HRB manifold drain port

Note that the indices for the identification of ports in this document are not present on the components themselves. For instance, the pilot oil port in the pilot oil supply manifold $\mathbf{A_S}$ is only marked with **A** on the pilot oil supply block.

Tightening torques

The following tightening torques apply (please refer to installation drawing for assignment to fasteners):

- Female thread in the axial piston unit and gearbox assembly:
  The maximum permissible tightening torques of the female threads must not be exceeded. Notes on the tightening torques can be found in the technical installation drawing and in section "Installation positions - general instructions for axial piston units" of the HRB data sheet RE 94850.
- Fittings:
  Observe the manufacturer's instructions regarding the tightening torques of the fittings used.
- Mounting bolts:
  For mounting bolts with metric ISO thread according to DIN 13 or thread according to ASME B1.1, we recommend checking the tightening torque in individual cases in accordance with VDI 2230.

- Threaded plugs:
  For the metal threaded plugs supplied with the axial piston unit and gearbox assembly, the required tightening torques of threaded plugs M_V apply. Values, see Table 12.

Table 12: Threaded plug tightening torques

Threaded port sizes		Required tightening torque of the threaded plugs M_V
Axial piston unit and gearbox assembly		
G 3/4	DIN 3852	90±5 % Nm
M33 x 2	DIN 3852	225±5 % Nm
Valve blocks		
G 1/4	DIN 3852	30±5 % Nm
G 1/4 (screw coupling)	DIN 3852	40±5 % Nm

Procedure

To connect the HRB components to the hydraulic system:

1. Remove the protective plugs and threaded plugs at the ports at which the connections are to be made according to the hydraulic circuit diagram.
2. Make sure that the sealing surfaces of the hydraulic ports and functional surfaces are not damaged.
3. Use only clean hydraulic lines.
4. Connect the lines in accordance with the installation drawing and the machine or system circuit diagram. Check whether all ports are connected or plugged with threaded plugs.
5. Tighten the fittings correctly (note tightening torques). Mark all correctly tightened fittings, e.g. with a permanent marker.
6. Check all pipes and hose lines and every combination of connecting pieces, couplings or connecting points with hoses or pipes to ensure they are in condition for safe working.

Improving corrosion characteristics

To improve the corrosion properties, it is urgently recommended to paint the flange at ports **P_V**, **T_V**, and **HD_V** and the open, unpainted surfaces of the HRB manifold or to give them corrosion protection treatment after hydraulically connecting the components. Also observe the notes for ring screws in chapter 7.4.3 "General instructions" on page 37.

Other unpainted surfaces of the HRB components and sensors (e.g., ventilation filter, name and identification plates and notices, red protective caps, manual drain valve, etc.) are not to be painted in the event of subsequent painting and must not generally be painted over.

7.4.8 Electrically connecting HRB components

NOTE
Short circuit in event of penetrating hydraulic fluid! Fluid can penetrate the product and cause a short circuit! ▶ Do not install axial piston units with electric components (e.g. electric controls, sensors) in a reservoir below the fluid level (inside-reservoir installation).

After completing the pressure system (pressure accumulator port to hydraulic system), a commissioning examination must be conducted, in Germany for example by an approved monitoring office (ZÜS). The examination must be performed by an expert assessor from the field of systems technology. Here, the serial numbers of the pressure accumulators will be recorded, the connection and configuration examined and the examination interval for the pressure accumulators defined (usually 10 years). In this connection, please note the national requirements in your country.

Use suitable seals and gaskets for electric (plug) connections as a precaution against corrosion and resulting short circuits.

The body or vehicle manufacturer is responsible for the selection and installation of the electrical wiring.
For electrically controlled HRB components, the electrical wiring must be connected in accordance with both the circuit diagram of the vehicle manufacturer and the HRB circuit diagram. Please comply with the notes on electric wiring in the data sheet.

1. Switch the relevant body and vehicle parts to voltage-free.
2. Electrically connect the HRB components. Before connecting, check that the connectors including all seals are intact. When connecting the control unit, make sure that socket HCU2 is electrically connected first, followed by socket HCU1.

Malfunctions could occur if the control unit sockets are electrically connected in the wrong order. In such cases, individual status indicators will light up. For this reason, pay great attention to the correct connection order when electrically connecting the control unit.
Proceed in the reverse order when disconnecting the control unit
(first disconnect HCU1, then HCU2).

Table 13: HRB electrical connections(see Fig. 25)

Designation	Function
APS	Accumulator pressure sensor
AS1	Axial piston unit swivel angle sensor 1
AS2	Axial piston unit swivel angle sensor 2
ATS	Accumulator temperature sensor
AV	Drive accumulator valve
BPS	Brake pressure sensor
CV	Clutch pressure valve
DS	Cardan shaft speed sensor
EPV	External pilot oil pressure
EV	Empty valve
FS	Filter signal
GT1 or GT2 or GT3	Gearbox oil temperature sensor
HCU1	HCU connector 1
HCU2	HCU connector 2
LS	Reservoir fill level
OBD	OBD diagnostics socket
PAS	Pilot oil accumulator pressure sensor
PFV	Prefill valve
PPS	Axial piston unit pressure sensor
PS	Axial piston unit speed sensor
PTS	Axial piston unit suction pressure/temperature sensor
PV	Pilot oil valve
RTS	Reservoir oil temperature sensor
SA	Axial piston unit solenoid A
SB	Axial piston unit solenoid B

The OBD diagnostics socket is to be placed in the cab and labeled as HRB diagnostics socket.

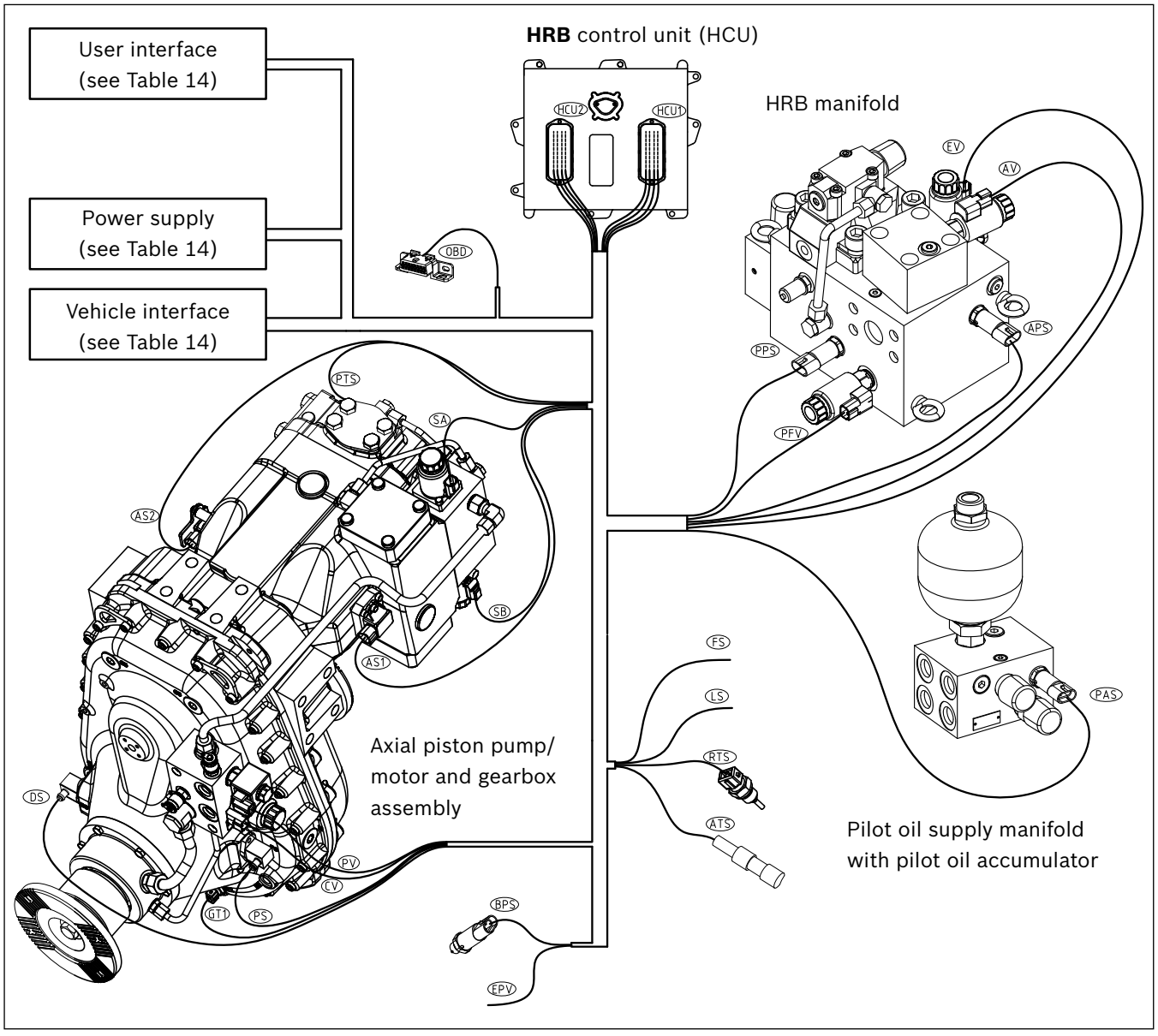

Fig. 25: HRB electrical connections

Table 14: Interfaces/power supply

User interface	Red HRB status indicator
	Yellow HRB status indicator/service
	Yellow HRB status indicator/high/low temperature
	Green HRB status indicator/HRB ready
	White HRB status indicator/launch gear recommendation
	HRB button
	Signal, analog - preselector
	GND, analog - preselector
	5V, analog - preselector
	Digital level switch 1
	Digital level switch 2
	Digital level switch 3
	U battery at user interface

Power supply	U battery
	GND battery
	Ignition
Vehicle interface	ABS
	ASR
	Engine running
	ACAN H
	ACAN L
	Retarder active
	Retarder active GND
	Engine brake deactivation
	Engine brake GND deactivation

7.4.9 Preparing electrical interfaces

⚠ WARNING

Danger through incorrect HRB function!
Reprogramming or subsequently modifying the vehicle interface is not permissible.
- Contact Bosch Rexroth Service to clarify the extent to which any planned modification to the vehicle interface could affect the HRB function.

Danger through incorrect HRB function!
Retrofitting of control units on the vehicle-CAN is not permissible during HRB integration on the vehicle-CAN.
- Contact Bosch Rexroth Service to clarify the extent to which any planned modification to the body interface or the vehicle-CAN could affect the HRB function.

The HRB requires the vehicle interfaces to be prepared. On refuse trucks in Europe, the interface to the vehicle that is relevant to the function is the body interface control unit (e.g. the "PSM" on Mercedes-Benz vehicles, or the "KSM" on MAN vehicles). As a rule, the interface architecture depends on the vehicle manufacturer and is implemented on the basis of ISO 11992, Part 3 or SAE J1939. The concrete realization by the vehicle manufacturer (e.g. availability of individual signals, etc.) must also be separately examined for each vehicle type in order to guarantee the full functionality and safety of the system.
Details of the prerequisites required for specific vehicles/manufacturers can be found in the description of interfaces.

Make certain that the description of interfaces with the vehicle stated and specified for installation in the order confirmation.

8 Commissioning

⚠ WARNING

Risk when working in the danger zone of a vehicle!

Danger to life, risk of injury or serious injuries!

- Pay attention to and rectify potential danger sources before operating the vehicle.
- Nobody is to be present in the danger zone of the vehicle.
- Always follow the instructions of the vehicle manufacturer during commissioning.

⚠ CAUTION

Commissioning of an incorrectly installed product!

Risk of injury and damage to equipment!

- Make sure that all electrical and hydraulic ports are connected or plugged.
- Only commission a completely installed fault-free product with original accessories from Bosch Rexroth.

Prior to the first commissioning, check with your Bosch Rexroth Service partner (see chapter 10.8 "Spare parts" on page 85 for address) about the necessary commissioning accessories (e.g., testing and filling equipment for the hydro-pneumatic pressure accumulator, control unit measuring adapter, diagnostics tester/software, etc.), see data sheet.

8.1 First commissioning

⚠ CAUTION

Risk of damage to the product!

Dry running roller bearings and sealing elements lead to wear and damage of components!

- Before operating the vehicle, always perform HRB commissioning. During this process, the axial piston unit and gearbox assembly is filled with hydraulic fluid and lubricating oil.

During all work for commissioning the HRB components, observe the general safety instructions and intended use detailed in chapter 2 "Safety instructions" on page 9.

- During the commissioning process, monitor the temperature of the hydraulic fluid in the reservoir to ensure that it lies within the permissible viscosity limits.

8.1.1 Hydraulic-mechanical commissioning

Perform hydraulic-mechanical commissioning as described in the following sections:

Check component fasteners

- Make sure that all mounting bolts for the HRB components are tightened in accordance with the tightening torques stated in the installation drawing.

Checking hydraulic connections

- Check all hydraulic connections as stated in the hydraulic circuit diagram for damage and for correct position.
- Check the tightening torques of the hydraulic fittings in accordance with the manufacturer's instructions.

Check system for leaks

- Carry out a visual inspection of the entire hydraulic system of the HRB for signs of leakage.

Setting/checking pre-charge pressure

DANGER

Danger to life!
The use of liquid nitrogen, oxygen or compressed air to charge the pressure accumulator could cause severe or even fatal injury.

- Do not use liquid nitrogen, oxygen or compressed air to charge the pressure accumulator.

CAUTION

Risk of damage to the product!
Commissioning a pressure accumulator that is not pre-charged will permanently damage the accumulator bladder!

- Pre-charge the pressure accumulator before commissioning.

Check the pre-charge pressure in the pressure accumulator as described below:

- Set/check the pre-charge pressure in all pressure accumulators as specified in this manual and correct as necessary.

To prevent the gas valve from being compressed when charging, only open the valve as far as necessary for the gauge to show pressure.
When charging, make sure that the charging device is correctly sealed to the gas valve.
Check the gas valve for damage after charging as a damaged gas valve could fail later.

- Hydro-pneumatic pressure accumulator for hybrid drive: 120 bar at 20 °C.

For correct function: Use nitrogen with a purity of at least 99.8 % for pre-charging the high-pressure accumulator.

Filling the axial piston unit and gearbox assembly

To prevent damage to the axial piston unit and gearbox assembly and to maintain correct function, professional filling and air bleeding is necessary.

Gearboxes and hydraulic circuits are two separate systems. Observe the respective requirements for cleanliness of the used fluids. When filling, use appropriate filling units with a microglass element.

Make certain that the suction line is always filled with hydraulic fluid during commissioning and operation (filter grade of filling unit: 3 µm). The axial piston unit and gearbox assembly should be filled with a filling unit (3 µm filter grade). Bosch Rexroth recommends that all filters be of a type with microglass element in order to maintain the required filtration rates. During commissioning and during operation, the gearbox must also always be filled with lubricating oil. Observe the notes on filling the HRB clutch prior to moving the vehicle.

The approved hydraulic fluids for the hydraulic circuit and the lubricating oil for the gearbox can be found in the data sheet.

1. Place a drip tray under the axial piston /gear unit to collect any hydraulic fluid that may escape.
2. Fill and air bleed the axial piston unit and gearbox assembly via the appropriate ports, see chapter 7.3 "Installation positions" on page 35 and chapter 7.4.7 "Hydraulically connecting the HRB" on page 42. The hydraulic lines of the system must also be filled.
3. Make certain that all ports are either piped up or plugged according to the hydraulic circuit diagram.
4. Fill the reservoir in accordance with the manufacturer's instructions.
5. Remove the oil filler screw and the oil level screw when filling the gearbox assembly with lubricating oil, see chapter 7.3 "Installation positions" on page 35.
6. Fill the gearbox assembly via the oil filler screw.
7. Add lubricating oil until the necessary oil level is reached at the oil level screw or until lubricating oil starts to escape.
8. Plug the oil filler opening and the borehole for the oil level screw.

8.1.2 Filling the HRB clutch

Before a vehicle with installed HRB is moved for the first time, the clutch of the HRB is to be filled with oil in order to prevent damage. This also applies for towing procedures performed prior to the first commissioning in which the drive axle turns. In the event of damages that result from insufficient lubrication, all warranty and liability claims against Bosch Rexroth are rendered void. Please contact Bosch Rexroth Service if you have questions.
The HRB clutch is part of the hydraulic circuit. When filling, use a filling unit with filter grade of 3 µm. Observe the notes on the required cleanliness of the oil according to the hydraulic fluid!

Preparation

1. Install the axial piston unit and gearbox assembly in the vehicle.
2. Connect all hoses.
3. Ensure the oil supply as for normal commissioning.

Filling operation

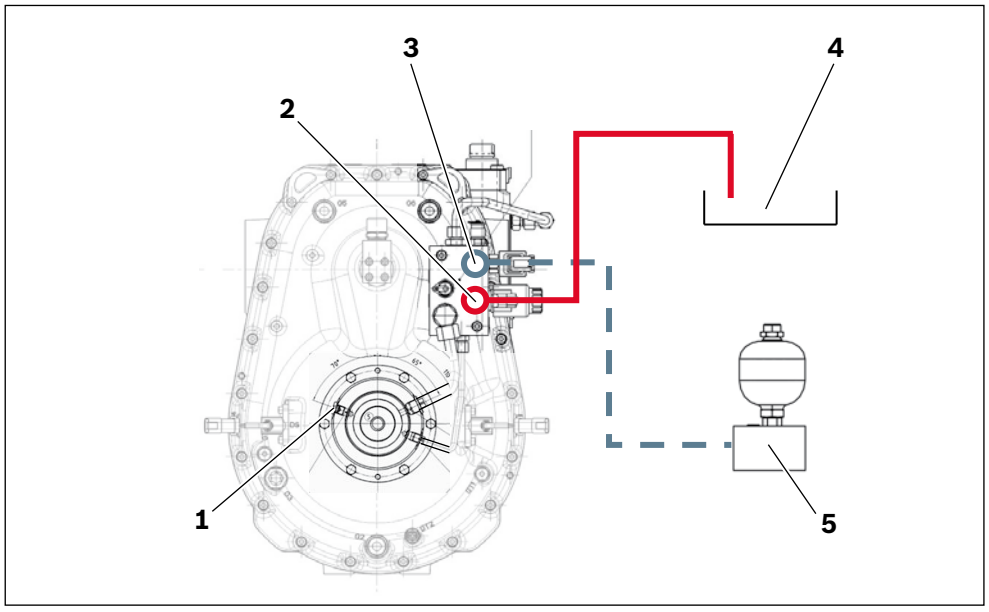

Fig. 26: Filling the HRB clutch

1 Flush oil port Y_F
2 Port T_G
3 Port P_G
4 Reservoir
5 Pilot oil supply

1. Release the fitting of flush oil port **Y_F** (air bleed the unit).
2. Fill the clutch via the case drain port at **T_G** (maximum 3 bar).
3. Conclude the filling operation when the oil runs uniformly and free of air bubbles form flush oil port **Y_F**.
4. Plug flush oil port **Y_F** with 18 Nm/13ft-lbs.

8.1.3 Air bleeding the system

Air bleeding the axial piston unit

Fill and air bleed the axial piston unit and gearbox assembly via the appropriate ports, see chapter 7.3 "Installation positions" on page 35 and chapter 7.4.7 "Hydraulically connecting the HRB" on page 42.
The axial piston unit must be completely filled with hydraulic fluid.

Air bleeding the HRB manifold

The HRB manifold is to be air bled via port **HD2**. Place a drip tray under the HRB manifold to collect any hydraulic fluid that may escape.

Air bleeding the hose lines

The hydraulic lines of the system must be filled and air bled.

8.1.4 Electrical commissioning

Checking wiring

- Check whether all electrical connections and cable ties are correctly seated.
- Check wiring for signs of damage and for correct seating.

Checking fuses

- Use the data sheet and the electric circuit diagram to check whether the fuses were properly dimensioned and correctly installed.

Make sure that the vehicle battery is connected and the ignition is switched on before testing the "Visual indicators" and the HRB button.

Checking visual indicators

- Check that all visual indicators for the HRB components are connected and that they light up correctly when they are activated.

Checking HRB **button**

- Press the HRB button.
  The green status indicator/HRB ready goes out.

8.1.5 System commissioning

To commission the system, you will need several tools (for specifications please consult your Bosch Rexroth Service partner, see chapter 10.8 "Spare parts" on page 85 or the data sheet for address. Please also contact your Bosch Rexroth Service partner for instructions on how to perform commissioning and the related documents for the acceptance tests that have to be conducted on all vehicles).

8.2 Recommissioning after standstill

⚠ CAUTION

Risk of damage by hydraulic fluid loss!

After long standstill periods, the axial piston unit and gearbox assembly may drain via the case drain line (air enters via the shaft seal ring) or via the service line (gap leakage). The bearings are thus insufficiently lubricated for recommissioning.

- Check the hydraulic fluid level in the hydraulic reservoir regularly; if necessary, recommission.

Depending on the installation conditions and ambient conditions, changes may occur in the HRB components which make recommissioning necessary.
Among others, the following criteria may make recommissioning necessary:

- Longer vehicle standstill periods
- Air and/or water in the hydraulic system
- Old hydraulic fluid
- Other contamination

- Before recommissioning, proceed as described in chapter 8.1 "First commissioning" on page 55.

9 Operation

Vehicle- or manufacturer-specific explanations can be found in the appendix under chapter 15.1 "Vehicle- and manufacturer-specific details" on page 103.

9.1 Control and indicator elements

9.1.1 Indicators

⚠ WARNING

Danger due to undisplayed system errors!
If the status indicators are not functional, system errors are not displayed for the driver.

- If the status indicators do not illuminate briefly after starting the ignition and, as a result, the indicator test fails, contact your Bosch Rexroth Service partner.

There are up to five status indicators in the vehicle that are relevant to the HRB, see Fig. 27 and Fig. 28. Fig. 27 shows an example of a central indicator instrument on the Mercedes-Benz Actros.
The red status indicator and the yellow status indicator/service must always be directly in the driver's field of vision[1)]. Please note: if the red status indicator and the yellow status indicator/service are only shown via a display, it must be directly in the driver's field of vision! It must be ensured that the corresponding signal is immediately detected and displayed. Depending on the specific vehicle model, up to three additional status indicators are mounted in the vehicle that may also be located in the peripheral field of view[2)]. To check the status indicators, all status indicators light up briefly when the ignition is switched on. Then only the green status indicator/HRB ready status indicator lights up.

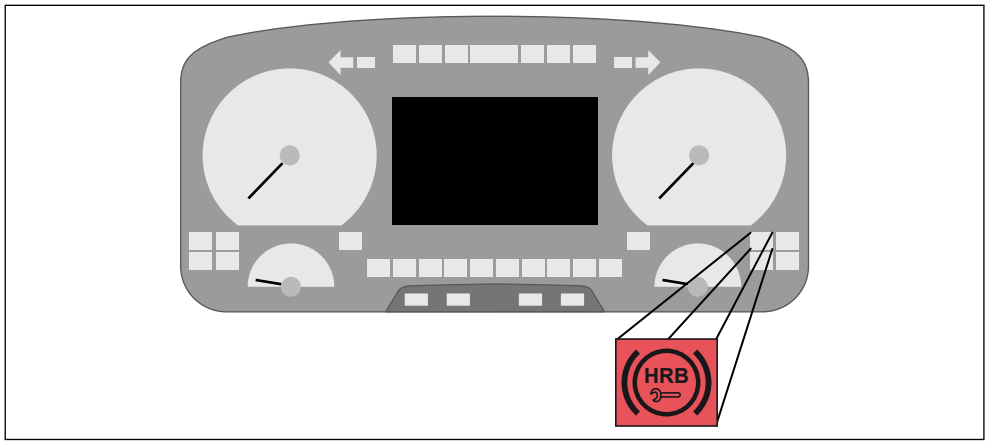

Fig. 27: HRB status indicators - example Mercedes-Benz Actros

[1)] The direct field of vision covers the area directly in front of the driver near the steering wheel, e.g., the central display.

[2)] The peripheral field of vision requires a noticeable head movement; it is possible to change the arrangement of the indicators, e.g., in the center console or further way.

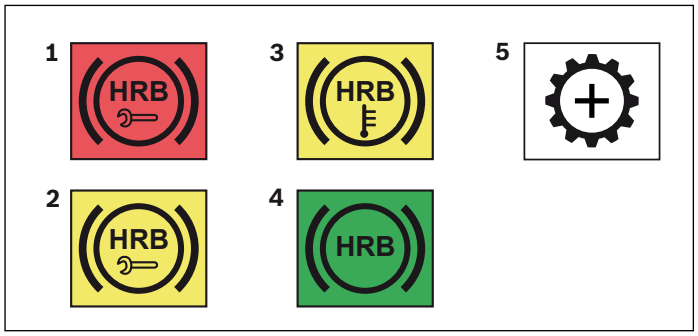

Fig. 28: HRB status indicators

9.1.2 Meaning of HRB status indicators

Red status indicator

Do not continue the journey.

- Stop the vehicle immediately in a safe place, taking the current traffic situation into account, and contact your responsible Bosch Rexroth Service partner, see chapter 10.8 "Spare parts" on page 85 for address.

To move the vehicle from the stop location, proceed as described below; further travel – even at walking pace – is not permissible!

CAUTION! Risk of excessive pressure in the system or of damage to the axial piston unit!

If the red status indicator is lit, the axial piston unit could be damaged when towing.

- Before towing, remove the cardan shaft between the HRB gearbox and the rear axle differential if the red status indicator is illuminated.
- The ignition must be switched off for towing.

CAUTION! Transport a vehicle with HRB on a low-loader!

Compressed gas containers are transported with the vehicle, meaning that the relevant hazardous goods regulations valid in the country concerned must always be observed.

- However, because the pressure accumulator is installed in the vehicle, transport is not covered by the ADR regulations (regulations for hazardous goods on the road), so no measures are necessary in this regard.

- The vehicle can be towed away. To do this, either the HRB gearbox must be disconnected from the rear axle differential (remove rear cardan shaft) or a recovery trailer is to be used on which the vehicle can be loaded so that the rear axle of the transported vehicle does not turn during transport.

Yellow status indicator/service

The HRB is due for maintenance. The HRB is not available but this does not represent a risk.

- Have the cause checked and eliminated as quickly as possible by your Bosch Rexroth Service partner, see chapter 10.8 "Spare parts" on page 85 for address.

Yellow status indicator/high/low temperature (optional)
The system is temporarily unavailable. The oil temperature is outside the permissible range.
As soon as the oil temperature returns to a level within the permissible limits, the status indicator will go out and the system will be available again.

Depending on the vehicle configuration, the yellow status indicator/high/low temperature may not be mounted. The temperature-related HRB status can, however, always be seen on the green status indicator. The green indicator goes out until the system is again within the permissible temperature limits.

Green status indicator/HRB ready
The HRB is active.
The HRB can be deactivated via the HRB button, see Fig. 29.

Depending on the vehicle configuration, the status indicator/HRB ready is located in the HRB button. Under certain circumstances, the status indicator may not be green.

While the HRB heats up to operating temperature, there may briefly be no acceleration capability available under certain circumstances even though the green status indicator/HRB ready is illuminated.

White status indicator/launch gear recommendation (optional)
The vehicle is at a standstill.
A higher launch gear can be selected on account of the accumulator charging state.

The white status indicator/launch gear recommendation is only available in vehicles with semi-automatic gear shifts, as these are the only gearboxes on which the launch gear can be influenced.

Continuous brake indicator (display and function depend on the respective vehicle; please refer to vehicle operating instructions for symbol)
A level > 0 was selected at the level switch. The status indicator is permanently active, even if there is currently no braking activity.

After the ignition was switched on, the yellow status indicator for the "continuous brake" may flash if the lever was not in the neutral position. The flashing will stop if the lever is moved once to the neutral position.
This indicator depends on the vehicle concerned. Please note the information given in the vehicle operating instructions.

9.1.3 HRB button

The HRB is automatically activated when the vehicle ignition is switched on.
To deactivate the system, the HRB button (**1**) (see Fig. 29) must be pressed. The green status indicator/HRB ready then goes out.

The status indicator is active regardless of whether or not the combustion engine is running.

Fig. 29: HRB-button - example Mercedes-Benz Actros

To reactivate the system, press the HRB button (**1**) again. The green status indicator/HRB ready is again active.

9.1.4 Setting the HRB braking effect

Level switch/preselector

The intensity of the HRB braking effect is selected with the level switch.
The HRB level switch can be permanently preselected and can even remain in the desired position when accelerating. The braking torque is automatically activated when the accelerator pedal is released.
The level switch can be implemented digitally in predefined torque levels or steplessly and analog as a continuous preselector.
For the switching logic of the level switch, please also observe the current electric circuit diagram of the HRB. There is a linear relationship between the analog voltage signal of the preselector and the HRB braking torque.

Control of braking deceleration depending of vehicle weight

As an alternative to the level switch, it is also possible with a suitable vehicle configuration to set a defined braking deceleration as a function of the vehicle weight. In this case, the braking torque is adjusted to the current vehicle weight.

9.2 How the HRB works

The HRB is automatically activated when the vehicle is started. As soon as the vehicle's combustion engine is started, the green status indicator/HRB ready illuminates.
The status indicator/HRB ready goes out as soon as an error occurs or the system is deactivated.
The service brake can be used at any time in addition to the HRB to decelerate the vehicle as they work completely independently. The ABS and traction control (ASC) safety systems are also unaffected by the HRB.

To optimize fuel savings, and intelligent control strategy is employed for the HRB, depending on temperature, mission profile etc. That means, for example, that the HRB may not be able to provide support until the pressure accumulator is completely empty. This is not a malfunction but rather part of the control strategy.

9.2.1 Brakes

⚠ WARNING

Risk of accident!

The HRB cannot be used to brake the vehicle to a standstill.

- You must be ready to use the service brake whenever the vehicle is braked with the HRB.

Risk of accident on a slippery road surface!

If the continuous brake (engine brake/retarder) or the HRB is applied on a slippery road surface, the wheels could lock and the vehicle could start to skid.

- Do not switch on or deactivate the continuous brake (engine brake/retarder) and HRB on a slippery road surface.
- When using antiskid chains (snow chains), do not switch on or deactivate the continuous brake (engine brake/retarder) and HRB.

When braking, an HRB deceleration torque can be selected on the level switch/ preselector. The timing of the preselection is of no relevance as the braking action is not initiated until the accelerator pedal is released.
The level switch/preselector can also be changed during the braking action.
The HRB is active under a defined vehicle speed of approx. 50 km/h.
As soon as the vehicle speed drops below the HRB maximum speed, the HRB will intervene and brake the vehicle practically constantly with the selected braking torque until a minimum speed of approx. 1 km/h is reached.
To stop the vehicle, especially when driving downhill, the service brake also needs to be used.
In contrast to the engine brake, the HRB braking torque is independent of the current gear engaged.
The capacity of the pressure accumulator is limited. For this reason, the HRB torque is continually reduced on lengthy downhill stretches as soon as the pressure accumulator is charged. In order to continue heavy braking of the vehicle, the driver must initiate suitable measures (e.g. gear shifting, activate the engine brake or service brake). This is true on all vehicles.

Increased use of the service brake decreases the attainable fuel savings.

9.2.2 Acceleration

⚠ CAUTION

Risk of accident!
If the axial piston unit and gearbox assembly blocks, unusually high resistance may be encountered when accelerating. As a result, vehicle movement with the aid of the combustion engine may be limited.

- ▶ In this case, manually switch to a lower launch gear. The vehicle can thereby be moved out of a danger zone. Deactivate the HRB. The vehicle is fully available without HRB. Check the HRB status indicators and contact Bosch Rexroth Service.

Acceleration depends on the pressure accumulator charging state.

- If the accumulator charge is insufficient to make a significant contribution to accelerating, the vehicle's response will be unchanged. Acceleration will be provided by the combustion engine alone.
- If the accelerator pedal is depressed and the HRB is available and active (green status indicator/HRB ready illuminated) and an HRB level is preselected, the HRB automatically generates an acceleration torque provided there is sufficient accumulator charging. As on a conventional vehicle, this acceleration torque depends on the position of the accelerator pedal. If the driver calls for more torque than the HRB can generate, the difference will be supplied by the combustion engine.
- When the pressure accumulator is discharged, the HRB will automatically be canceled and the combustion engine will supply the full drive torque.

Depending on the charge state of the pressure accumulator, the HRB can also generate so much power that the vehicle can pull away in a higher gear with an semi-automatic gear shifts. This will reduce fuel consumption and emissions further. Whether or not this is possible is checked when the vehicle is at a standstill and, if mounted, is indicated by the white status indicator/launch gear recommendation in the instrument cluster, see chapter 9.1.1 "Indicators" on page 60.

9.2.3 Stopping the vehicle

After the vehicle has been stopped and the ignition switched off, the hydraulic pressure in the reservoir will automatically be relieved. Relieving can be heard by a hissing noise and takes about 5 minutes with a charged accumulator volume of 64 l.

9.2.4 Manually draining the pressure accumulator

⚠ CAUTION

Risk of personal injury and damage to equipment!
If maintenance work is performed on a hydraulic system or pressure accumulator that has not been depressurized, and/or in the event of damage caused by an accident, there is an increased risk of injury from the pressure accumulator bursting or from hydraulic fluid escaping under high pressure.

- Before performing maintenance work of the hydraulic system and in the event of accident damage close to the pressure accumulator, the hydraulic pressure in the hydro-pneumatic pressure accumulators must be completely relieved.
- Before performing maintenance work, switch the ignition off and wait until the pressure is completely drained.

Risk of suffocation through nitrogen!
There is a risk of suffocation when letting off nitrogen.

- Only let nitrogen off from the pressure accumulators in well ventilated places.

Risk of personal injury and damage to equipment!
The pressure accumulators will remain charged with nitrogen after the oil has been drained. The pressure will be at least 120 bar.

- After performing maintenance work, close the valve on the hydro-pneumatic pressure accumulator again.

The hydraulic pressure in the HRB primary accumulators can be manually relieved by opening the drain valve (**1**) in the HRB manifold (see Fig. 30). In doing so, the valve is to be opened slowly.

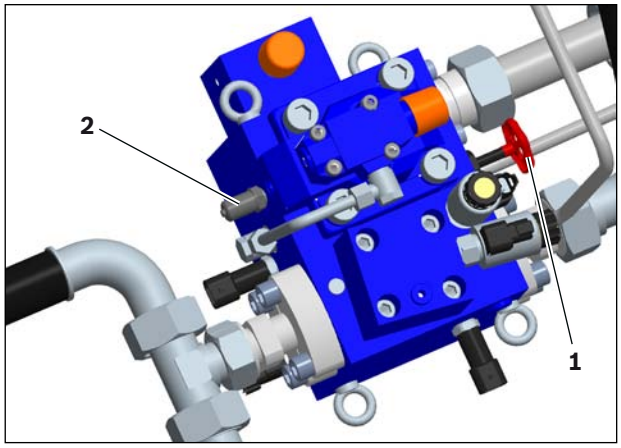

Fig. 30: Drain valve pressure accumulator

1 Drain valve
2 Gauge port $HD1_v$

The accumulator pressure can be checked with a gauge at the gauge port (**2**). The port is labeled with **HD1** at the HRB manifold, (see Fig. 30).

9.2.5 Manually draining the pilot oil accumulator

⚠ CAUTION

Risk of personal injury and damage to equipment!

The accumulator will remain charged with nitrogen after the oil has been drained. The pressure will be at least 30 bar.

- ▶ After performing maintenance work, close the miniature gauge port again.

The hydraulic pressure in the pilot oil accumulator can be manually relieved at the gauge port (**1**) in the gearbox control block (see Fig. 31).

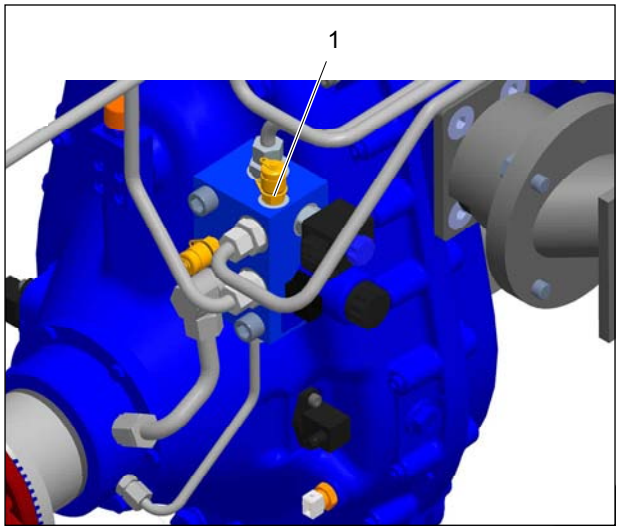

Fig. 31: Accumulator drain valve

1 Gauge port MPG

10 Maintenance and repair

NOTE

Inspection and maintenance work carried out too late!
Damage to equipment!
- Carry out the specified inspection and maintenance work at the intervals described in this manual.

10.1 Cleaning and care

⚠ WARNING

Risk of personal injury and damage to equipment!
Improper repairs and maintenance could cause damage to the vehicle and/or personal injury.
- Do not attempt to repair or service the HRB without the necessary technical knowledge and tools.

NOTE

Damage to seals and electrical system by mechanical effects!
The water jet of a power washer may damage the seals and electrical system of the HRB components!
- Do not point a power washer at sensitive components, e.g., seals, electrical components and plug connections.

For cleaning and care of the HRB, observe the following:
- Check whether all seals and fittings on the connections are securely seated to ensure that no moisture can penetrate into the HRB components during cleaning.
- Use only water and, if necessary, a mild detergent to clean the HRB components. Never use solvents or aggressive detergents.
- Remove external coarse dirt and keep sensitive and important components, such as solenoids, valves, indicators and sensors, clean.

10.2 Inspection

⚠ CAUTION

Malfunctions/complete HRB system failure following an accident!

After an accident, malfunctions and/or a complete HRB system failure could occur.

- After an accident, stop the vehicle, apply the parking brake, switch off the ignition and slowly open the manual drain valve of the HRB.
- Check the HRB for signs of leaking oil and initiate containment measures accordingly (e.g. notify emergency services and/or drain off the hydraulic oil from the hydraulic reservoir).
- Damaged high-pressure components are to repaired on the spot or the vehicle will have to be towed away.
- If high-pressure components are defective, the vehicle can only be towed away with the cardan shaft removed between the HRB gearbox and the rear axle differential. The ignition should be switched off.
- Have a detailed inspection of the HRB performed. Here, the complete system is to be checked for leaks, damage and correctly seated components. In addition, the oil level must be checked and the electrical wiring system examined.

Oil leakage/damage to components due to bladder burst with non-deactivated HRB!

Following a bladder burst in one of the pressure accumulators, the release of the nitrogen may result in a large increase in volume and cause foaming in the reservoir. If operation of the HRB continues following a bladder burst, considerable oil leakage is possible via the ventilation filter on the reservoir.

- A bladder burst can be detected by increased operating noise of the axial piston unit and gearbox assembly.
- If a bladder burst is suspected, immediately deactivate the HRB. Note that after an ignition start following such an event, the HRB must again be deactivated, since the HRB is automatically active on ignition start.
- In this case, do not open the manual drain valve!

To guarantee lasting and reliable function of the HRB, Bosch Rexroth recommends regularly checking the hydraulic system and the hydro-pneumatic pressure accumulator as well as the axial piston unit and gearbox assembly. For inspection intervals, see Table 15.

Table 15: Inspection schedule

Task to be carried out		Interval
Hydraulic system	Check level of the hydraulic fluid in the reservoir.[1)]	Daily
	Check the normal operating temperature (comparable load condition).	Weekly
	Check quality of the hydraulic fluid. At a minimum, degree of cleanliness of 19/17/14 according to ISO 4406 must be ensured, optimum is 17/15/11 - see data sheet.	Yearly or every 2000 h (whichever occurs first)
	Check the HRB for leakage. Early detection of a loss of hydraulic fluid can help to identify and eliminate errors on the HRB. For this reason, Bosch Rexroth recommends that the hydraulic system always be kept in a clean condition.	Daily
	Check the manual drain valve for free movement and function.	Yearly
Filter with contamination indicator	If installed, check the mechanical contamination indicator of the filter:[2)] perform filter maintenance if necessary.	Weekly during the first month following commissioning, monthly thereafter
Electrical wiring and hydraulic lines	Check the electric wiring system for routing and signs of damage (visual check).	Weekly
	Visual check of hydraulic lines for routing, leaks and damage (abrasion, cuts, cracks).	Weekly
Hydropneumatic pressure accumulator[3)]	Check the pre-charge pressure $\mathbf{P_0}$ and set to the correct value.	Weekly after charging in the first month, then half-yearly or every 1000 h (whichever comes first)
	The status of the accumulator bladder must be checked regularly. This status depends on the number of cycles completed.	Half-yearly or every 1000 h (whichever occurs first)
	Visual check for rust, mechanical damage, leaks, secure mounting. If rust is found on the gas-filling valve, this must be replaced. To do this, observe the instructions in chapter 10.4.3 "Checking the interior of the hydro-pneumatic pressure accumulator" on page 75.	Weekly
Axial piston unit and gearbox assembly	Check the axial piston unit and gearbox assembly for noise development.	Daily
	Check fastener elements for tight seating. All fasteners have to be checked when the system is switched off, depressurized and cooled down.	Monthly

Task to be carried out		Interval
Gearbox	Check the quality of the lubricating oil. At a minimum, degree of cleanliness of 20/18/15 according to ISO 4406 must be ensured.	Every 50,000 km or at the latest after one year
Fasteners and brackets	Check the fasteners and brackets (including the fasteners for the pressure accumulator temperature sensor) for firm seating, corrosion and fractures.	Half-yearly or every 1000 h (whichever occurs first)

[1] Check the oil level with completely emptied pressure accumulators. To do this, park the vehicle on a flat surface and deactivate the ignition. Wait approx. 5 minutes before reading the oil level to allow the accumulators to empty completely.

[2] Note that a soiled filter may, in some cases, only be indicated while the engine is running.

[3] When performing maintenance on the hydro-pneumatic pressure accumulators, the national legislation in the respective country must be observed.

10.3 Maintenance

The HRB components require very little maintenance if they are used as intended. The service life of the hydraulic HRB components is heavily dependent on the quality of the hydraulic fluid. For this reason, we recommend changing the hydraulic fluid at least once per year or every 2000 operating hours (whichever occurs first) or having it analyzed by the hydraulic fluid manufacturer or a laboratory to determine its suitability for further use (at a minimum, degree of cleanliness of 19/17/14 according to ISO 4406, optimum is 17/15/11 - see data sheet).
The service life of the axial piston unit and gearbox assembly is limited by the service life of the built-in bearings. The service life on the basis of the load cycle can be requested from the responsible Bosch Rexroth Service partner, see chapter 10.8 "Spare parts" on page 85 for address. Based on these details, a maintenance period is to be determined by the vehicle manufacturer for the replacement of the bearings and included in the maintenance schedule of the hydraulic system. The service life may differ, depending on the hose system fitted. Always comply with the manufacturer's instructions.

Table 16: Maintenance schedule

Task to be carried out		Interval
Electrical wiring and hydraulic lines	Renew all hydraulic lines.	Every 6 years or every 12.000 h (whichever occurs first)
Hydro-pneumatic pressure accumulators[1]	Perform an internal check of the pressure accumulators (see chapter 10.4.3 "Checking the interior of the hydro-pneumatic pressure accumulator" on page 75).	After 10 years and after an interval specified by a named office
	Replace bladder	Is indicated by the yellow status indicator/ service
Gearbox[2]	Change lubricating oil in axial piston unit and gearbox assembly	Every 50,000 km or no later than one year of if degree of cleanliness of 20/18/15 according to ISO 4406 is no longer guaranteed.

Task to be carried out		Interval
Hydraulic system	Change hydraulic fluid in hydraulic system	Annually, every 2000 operating hours or if degree of cleanliness of 19/17/14 according to ISO 4406 is no longer guaranteed.
Pressure-relief valve on accumulator (if fitted)	Check function together with accumulator maintenance	Every 10 years

[1] When performing maintenance on the hydro-pneumatic pressure accumulators, the national legislation in the respective country must be observed.

[2] The multi-plate clutch is maintenance free.

Table 17: Periodic technical monitoring (official offices)

Task to be carried out
Check the electric wiring system for routing and signs of damage (visual check).
Visual check of hydraulic lines for routing, leaks and damage (abrasion, cuts, cracks).
Check of lamp statuses (in case of yellow or red faults, the system is to be repaired by an authorized specialist company).

10.4 Maintenance instructions

⚠ CAUTION

Risk of personal injury and damage to equipment!

Performing maintenance work on HRB components that are not depressurized could cause hydraulic fluid to escape under high pressure, which could cause injury or property damage.

- Before performing maintenance work, switch the ignition off and wait until the pressure is completely drained.
- Before performing maintenance work, the pressure in the hydro-pneumatic pressure accumulator must be completely discharged.
- The HRB components can be transported with a forklift truck or with a lifting device. Before transport, make certain that the forklift truck or lifting device has adequate lifting capacity.

Before performing maintenance work on the hydraulic system, the pressure in the hydro-pneumatic pressure accumulator must be completely discharged.
As a rule, this happens automatically within about 5 minutes with a filled reservoir volume of 64 l after switching off the ignition (audible whirring noise).
However, for reasons of safety, the manual drain valve (**1**) must also be opened slowly after this time has elapsed. This is fitted to the HRB manifold (see Fig. 32).

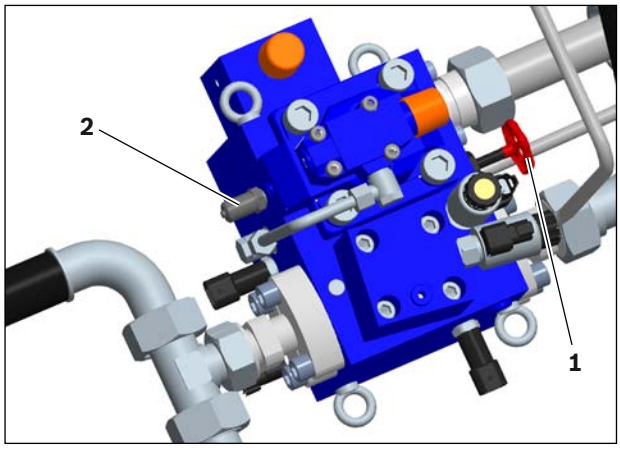

Fig. 32: Manual drain valve

1 Drain valve
2 Gauge port $HD1_v$

A pressure measuring device (e.g., pressure gage) must be used at one of the provided ports (port **$HD1_v$** (**2**) on the HRB manifold, see Fig. 32) to verify that the pressure has been completely released.
If maintenance work is to be performed on the pilot oil supply, the pressure in the pilot oil accumulator must first be released. To do this, proceed as described in chapter 9.2.5 "Manually draining the pilot oil accumulator" on page 67.

10.4.1 Gear oil change

Oil type: see data sheet
Oil quantity: 3.3 liters if installation position not rotated, 4.5 liters if installation position is rotated 90° clockwise/counter-clockwise

- The gear oil is to be drained off at the port defined in chapter 7.3 "Installation positions" on page 35. The gear oil is to be collected in a suitable vessel and disposed of in accordance with the environmental regulations valid in your country.
- The gearbox is also filled and the oil level checked at the ports defined in chapter 7.3 "Installation positions" on page 35. The procedure is specified in chapter 8.1.1 "Hydraulic-mechanical commissioning" on page 56.

10.4.2 Hydraulic fluid change

⚠ DANGER

Risk of fatal injury due to maintenance work on pressurized hydraulic system!
Risk of fatal injury due to maintenance work on pressurized hydraulic system! Performing maintenance work on a hydraulic system that has not been depressurized or on pressurized hydraulic components could cause severe injuries or burns.

- Before performing maintenance work, switch the ignition off and wait until the pressure is completely drained.
- Before beginning the maintenance work, pressure must be relieved in the hydraulic system and the hydraulic components via the specified ports (see chapter 9.2.4 "Manually draining the pressure accumulator" on page 66).

The following notes about changing hydraulic fluid are to be observed:

1. The hydro-pneumatic pressure accumulators are to be drained manually (see chapter 9.2.4 "Manually draining the pressure accumulator" on page 66). Slowly open the drain valve and leave the drain valve open throughout the entire maintenance process.
2. Check whether the axial piston unit and gearbox assembly and the hydraulic hoses have cooled down sufficiently for oil to be drained off safely. Wear suitable protective clothing as hot oil could cause burns.
3. Place a drip tray under the components to be drained to collect any hydraulic fluid that may escape.
4. Drain off the hydraulic fluid from the hydraulic reservoir through the relevant port in accordance with the manufacturer's instructions.
5. The hydraulic fluid in the axial piston unit is to be drained at the port defined in chapter 7.3 "Installation positions" on page 35.
6. The hydraulic fluid in the hydraulic lines between the hydro-pneumatic pressure accumulators and the HRB manifold can be drained via port **$HD2_v$** on the HRB manifold.
7. Drain off the pressure in the pilot oil system as follows:
   - Hold a pressure gauge line with a miniature gauge port in an oil vessel.
   - Slowly connect the line to miniature gauge port **MP_G** (pilot oil gauge port) on the axial piston unit and gearbox assembly.
   - Drain the pilot oil accumulator and the line completely.
8. To refill the system, all opened threaded plugs are to be tightened again with the corresponding torques. Close the drain valve that was opened to manually drain the hydro-pneumatic pressure accumulators.
9. The system is to be filled via the ports specified in chapter 7.3 "Installation positions" on page 35.
10. The system is to be commissioned according to chapter 8.2 "Recommissioning after standstill" on page 59.

Dispose of the hydraulic fluid and lubricating oil in accordance with the currently applicable environmental regulations in your country.

10.4.3 Checking the interior of the hydro-pneumatic pressure accumulator

- The interior check of hydro-pneumatic pressure accumulator must be performed by a named office in compliance with the pressure vessel directive. Please comply with this and with any local legislation valid in the country concerned.
- After the interior check, the named office will specify a new inspection interval at which the hydro-pneumatic pressure accumulator is to be subjected to another interior check.

10.4.4 Removing the hydro-pneumatic pressure accumulators and replacing the accumulator bladders

DANGER! Risk of fatal injury due to maintenance work on pressurized hydraulic system!
Performing maintenance work on a hydraulic system that has not been depressurized or on pressurized hydraulic components could cause severe injuries or burns.

- ▶ Before performing maintenance work, switch the ignition off and wait until the pressure is completely drained.
- ▶ Before beginning the maintenance work, pressure must be relieved in the hydraulic system and the hydraulic components via the specified ports (see chapter 9.2.4 "Manually draining the pressure accumulator" on page 66).

1. Check whether axial piston unit and gearbox assembly and the hydraulic hoses and the pressure accumulators have cooled down sufficiently for the hydraulic fluid to be drained off safely. Wear suitable protective clothing as hot hydraulic fluid could cause burns.
2. Place a drip tray under the components to be drained to collect any hydraulic fluid that may escape.

DANGER! Risk of injury from hydraulic system under pressure!
When the drain valve is closed, a very high pressure can build up due to the effect of heating and this could cause severe injuries when disconnecting the hydro-pneumatic pressure accumulator.

- ▶ Check the pressure at the hydro-pneumatic pressure accumulator immediately before disconnecting.
- ▶ Before disconnecting the hydro-pneumatic pressure accumulator from the system, make sure that the hydro-pneumatic pressure accumulator is completely depressurized.
- ▶ Before disconnecting the hydro-pneumatic pressure accumulator, make sure that the gas pressure is completely relieved.

3. Manually drain the hydro-pneumatic pressure accumulator by slowly opening the drain valve (see chapter 9.2.4 "Manually draining the pressure accumulator" on page 66). A pressure measuring device (e.g., gauge) must be used at one of the provided ports (port **HD1$_v$** (**2**) on the HRB manifold to verify that the pressure has been completely released, see Fig. 32 on page 73).
4. If the hydraulic fluid has not been drained from the hydraulic system, the drain valve will have to be closed immediately before disconnecting the pressure accumulators. This is necessary to prevent the oil from flowing out of the

hydraulic reservoir. Check that the pressure is reduced to 0 bar at port **HD1$_v$** once more after you have closed the drain valve.

5. Remove the protective cap(s) from the gas-filling valve and if necessary the lead seal.
6. Release the pre-charge pressure in the bladder using a testing and filling unit. Make sure the testing and filling unit is used in accordance with the operating instructions.

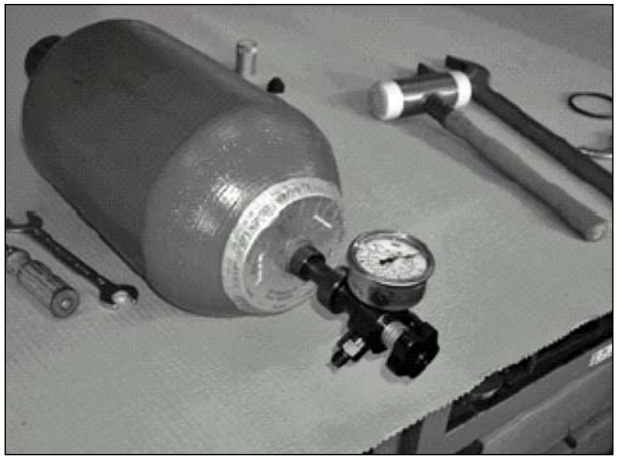

Fig. 33: Letting off the pre-charge pressure

Removing the pressure accumulator

1. If the pressure remains at 0 bar at port **HD1$_v$** when the drain valve is closed, carefully disconnect the hydro-pneumatic pressure accumulator.
2. Fix the hydro-pneumatic pressure accumulator horizontally in place in a vise or similar clamping system. Make sure that the shell is not damaged.
3. Unscrew the gas-filling valve.

Fig. 34: Unscrewing the gas-filling valve

4. Unscrew the nut from the gas-filling valve and remove the company plate.

Fig. 35: Removing the gas-filling valve

5. Unscrew the flange or the reducer from the liquid side. Remove the venting screw (not present on all models) without damaging the sealing ring.

Fig. 36: Removing the venting screw

6. With the pressure accumulator fully relieved (gas and liquid), the fluid valve is either open or it can be opened by hand. If this cannot be determined, no further work is to be performed! Contact Bosch Rexroth Service, see chapter 10.8 "Spare parts" on page 85 for address.

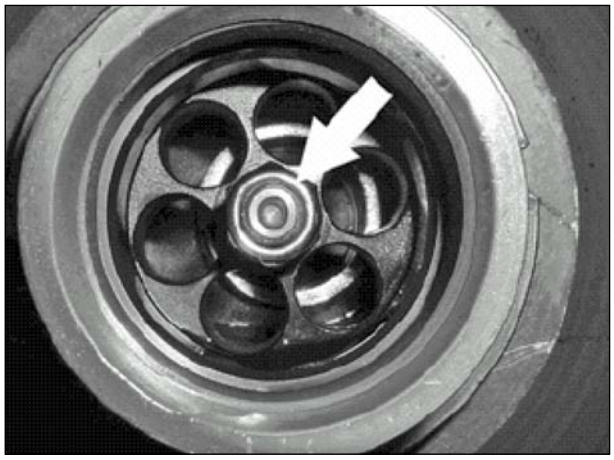

Fig. 37: Opening the fluid valve

7. Unscrew the ring nut and remove the spacer ring.

Fig. 38: Removing the ring nut and the spacer ring

8. Carefully press the fluid valve into the body.

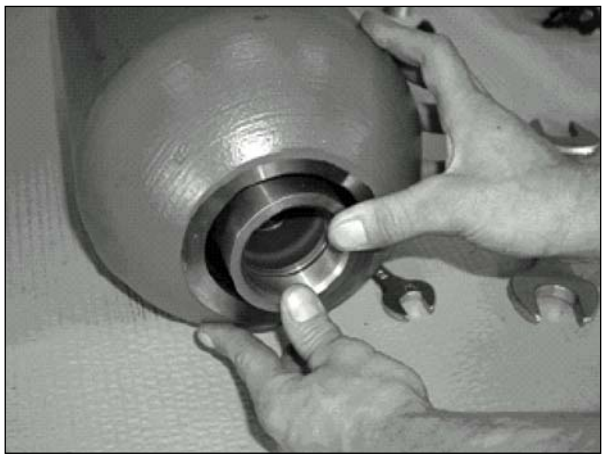

Fig. 39: Pressing in the fluid valve

9. Remove the O-ring.

10. Unscrew the split rubber ring/retaining ring from the body of the fluid valve, fold it together carefully and pull it out of the vessel.

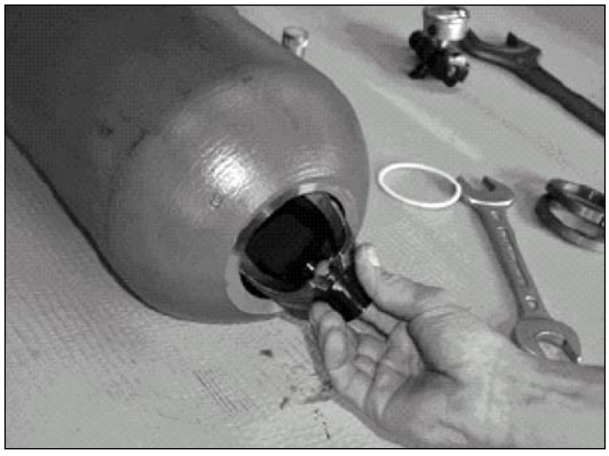

Fig. 40: Unscrewing rubber ring

11. Remove the fluid valve.
12. Remove the bladder through the opening on the liquid side.

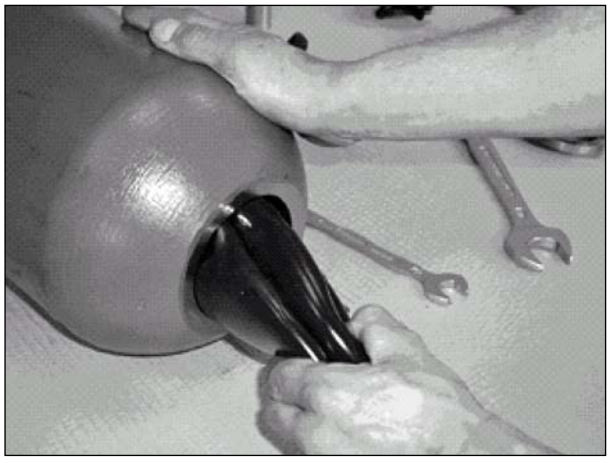

Fig. 41: Removing the bladder

10.5 Cleaning, checking and repairing

1. Clean all metal parts of the pressure accumulator carefully and dry them with compressed air.
2. Make sure that the inside of the vessel shows no sign of damage.
3. Press on the valve collar to check that the valve is working correctly.
4. Make sure that the retaining nut for the valve tappet is firmly seated.
5. Make sure that the O-rings have absolutely no signs of abrasion or other damage.
6. Make sure that the bladder has no signs of damage. Replace it if necessary.
7. Never attempt to repair the bladder.
8. Replace all parts that show signs of wear or damage.

10.6 Assembly of the hydro-pneumatic pressure accumulator

1. Make sure there are no contaminants remaining in the pressure accumulator.
2. To make reinstallation of the bladder easier, lubricate it and the inside of the vessel liberally with the operating fluid.
3. Squeeze the upper section of the bladder and insert it through the opening on the liquid side.

Fig. 42: Squeezing the bladder

4. Loosely screw on the company plate and the nut of the gas-filling valve.

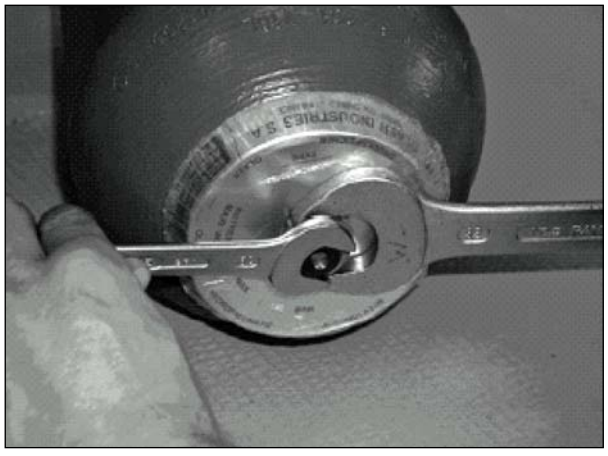

Fig. 43: Company plate of the gas-filling valve

5. Make sure that the bladder is not folded or twisted.
6. Insert the fluid valve into the vessel.

Fig. 44: Inserting the fluid valve

7. Insert the split rubber ring/retaining ring into the vessel and slide it onto the fluid valve. Pull the fluid valve back so that it makes contact with the inside of the vessel.
8. Install the O-ring and the spacer ring.

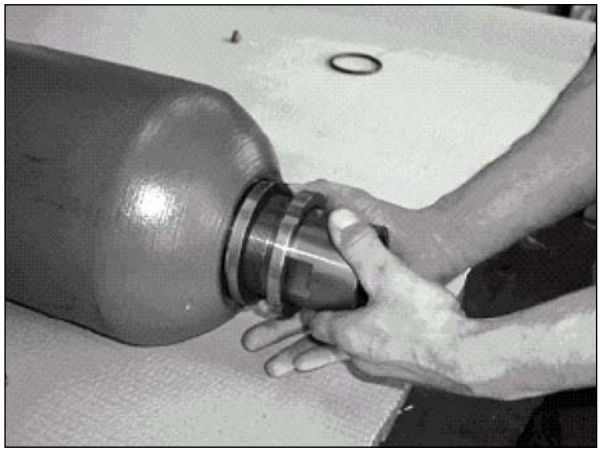

Fig. 45: Installing the O-ring and the spacer ring

9. Screw on the ring nut. Center the parts by carefully striking the fluid valve from different sides with a plastic hammer and at the same time continuing to screw on the ring nut by hand.

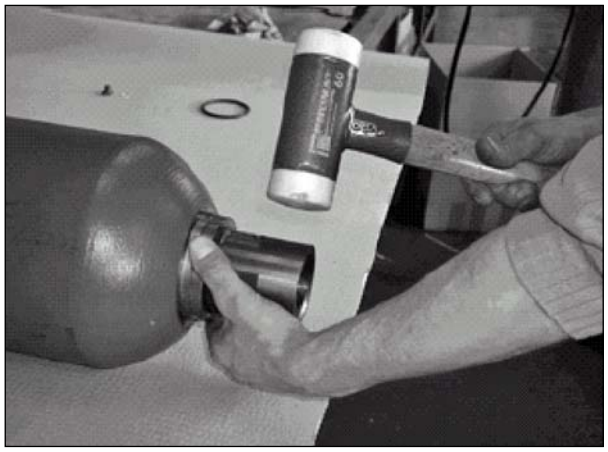

Fig. 46: Screwing on the ring nut

10. Securely tighten the ring nut.

Fig. 47: Tightening the ring nut

11. Before installing the reducer on the liquid side, the bladder must slowly be filled with nitrogen at a pressure of 1 – 1.5 bar using the testing and filling unit. Operate the testing and filling unit in accordance with the relevant operating instructions.
12. Make sure that the fluid valve closes properly by checking the movement of the valve tappet.
13. Install the venting screw with seal (not present on all models).

Fig. 48: Installing the venting screw

14. Securely tighten the company plate and the nut of the gas-filling valve.

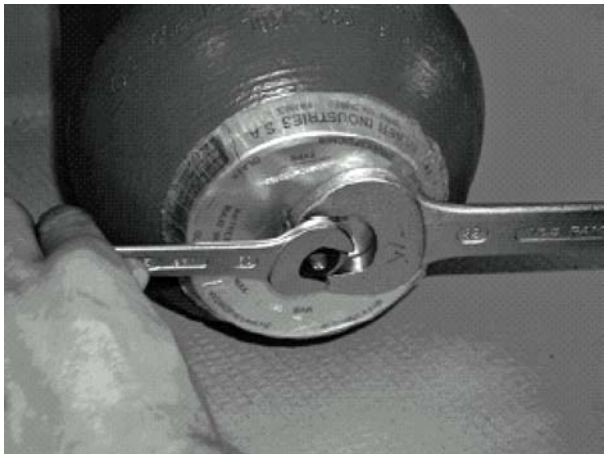

Fig. 49: Tightening the company plate, nut and gas valve body

15. Then install the pressure accumulator according to chapter 7 "Installation" on page 33.

10.6.1 Recommissioning the hydro-pneumatic pressure accumulator

⚠ CAUTION

Mechanical properties must not be changed!
It is not permissible to perform any maintenance work that could change the mechanical properties of the hydro-pneumatic pressure accumulator. This could result in the hydro-pneumatic pressure accumulator bursting, which could cause severe personal injury and material damage.

- Do not do anything to the hydro-pneumatic pressure accumulator that could change its mechanical properties (welding, soldering, drilling).
- Do not modify the hydro-pneumatic pressure accumulator or its components.

The hydro-pneumatic pressure accumulators and equipment may only be commissioned by qualified personnel, see chapter 2.4 "Personnel qualifications" on page 10.

1. Fill the hydro-pneumatic pressure accumulator with nitrogen as described in the instructions for the hydro-pneumatic pressure accumulator.
2. Slowly open the manual drain valve.
3. Before pressurizing the system, it should be air bled via the venting screw (if fitted).
4. Carefully retighten the venting screw (if fitted) as soon as the hydraulic fluid starts to escape. Then pressurize the hydraulic system to maximum pressure and check that there are no leaks at the connections and seals.
5. Perform the system commissioning as described in chapter 8.1 "First commissioning" on page 55.

Hydro-pneumatic pressure accumulators are subject to certain government pressure vessel regulations. These regulations require pressure accumulators to be subjected to regular examination. The interval for these examinations varies from one jurisdiction to another. Check the relevant intervals for your company from the responsible authorities.

10.6.2 Replacing the complete hydro-pneumatic pressure accumulator

1. To remove the hydro-pneumatic pressure accumulator, proceed as described in chapter 10.4.4 "Removing the hydro-pneumatic pressure accumulators and replacing the accumulator bladders" on page 75, steps 1 to 6.
2. Install the new hydro-pneumatic pressure accumulator according to chapter 7 "Installation" on page 28.
3. Fill the hydro-pneumatic pressure accumulator as described in the instructions for the hydro-pneumatic pressure accumulator.
4. In Germany, the serial number of the new hydro-pneumatic pressure accumulator must be entered by the named office in the assembly group approval. Please comply with valid national regulations in the country concerned.
5. When installing a new hydro-pneumatic pressure accumulator, the cycle counter in the HRB control unit must be reset by the vehicle manufacturer.

If a new pressure accumulator is installed, the serial number must be entered by the named office in the assembly group approval.

10.6.3 Replacing the HRB control unit

When removing the control unit or disconnecting the control-unit plug, first remove fuses in the following order: clamp 15, clamp 30. This ensures that the control unit will not be damaged and that no misdiagnoses are stored within the control unit.

1. Switch off the ignition.
2. Remove the HRB fuses in the following order: clamp 15, clamp 30.
3. Disconnect the HCU1 connector.
4. Disconnect the HCU2 connector.
5. Remove the old control unit (it is fastened with 8 screws).
6. Install the new control unit (it is to be fastened with 8 screws).
7. Connect the HCU2 connector.
8. Connect the HCU1 connector.
9. Plug the HRB fuses back in.
10. Activate the ignition:
    All HRB status indicators should first illuminate briefly on the display.
    The green status indicator should then illuminate continuously.

10.7 Repair

Components may only be repaired by a Bosch Rexroth Service partner. See chapter 10.8 "Spare parts' on page 85 for address. The system may need to be recommissioned after replacing or servicing components.

If any of the plastic cover on the pressure accumulators are damaged, the valve should be examined for damage, rust and correct function. If the valve is intact, the damaged cover is to be replaced.

10.8 Spare parts

⚠ CAUTION

Use of unsuitable spare parts!
Spare parts that do not meet the technical requirements specified by Bosch Rexroth may cause personal injury or property damage!

- Use only original spare parts from Rexroth to repair the HRB components. The functional reliability of the HRB cannot otherwise be guaranteed and the warranty is rendered void.

The spare part lists of the HRB components are system-specific. When ordering spare parts, state the material and serial numbers of the HRB components as well as the material numbers of the spare parts.
Address all questions regarding spare parts to your responsible Bosch Rexroth Service partner or the service department of the plant that manufactures the HRB components.

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For the addresses of foreign subsidiaries, please refer to
`www.boschrexroth.com/addresses`

11 Removal and replacement

11.1 Required tools

Removal can be performed with standard tools. No special tools are necessary.

11.2 Preparing for removal

1. Secure the vehicle (apply the handbrake, use chocks and remove the ignition key).
2. Disconnect the vehicle battery as described in the documentation provided by the vehicle manufacturer.
3. Manually relieve the hydro-pneumatic pressure accumulators (see chapter 9.2.4 "Manually draining the pressure accumulator" on page 66).
4. Leave the drain valve open during removal.
5. Check whether the axial piston unit and gearbox assembly and the hydraulic hoses have cooled down sufficiently for them to be removed safely.

11.3 Removing the axial piston unit

Proceed as follows to remove the axial piston unit and gearbox assembly:

1. Relieve the hydraulic system according to chapter 9.2.4 "Manually draining the pressure accumulator" on page 66.
2. Drain the hydraulic system according to chapter 10.4.2 "Hydraulic fluid change" on page 74, steps 1 to 7.
3. Remove the hydraulic hoses from the components to be removed.
   – To do this, loosen the hydraulic lines and collect the escaping hydraulic fluid in the collector. The hydraulic hoses could still be filled with hydraulic fluid. Care must therefore be taken during removal.
4. Remove the oil drain screw from the gearbox assembly, see chapter 7.3 "Installation positions" on page 35 and drain the lubricating oil completely into a prepared drip tray.

CAUTION! Damage to the cardan shafts!
If the universal joints on the cardan shafts are installed in a different orientation during a subsequent installation, this could damage the cardan shafts.

- Re-orienting the universal joints on the cardan shafts is therefore not permissible.
- Before removing, mark the position of the universal joints on the cardan shafts.

5. Mark the universal joints on the cardan shafts.
6. Place a drip tray under the axial piston unit and gearbox assembly to collect any hydraulic fluid or lubricating oil that may escape.

The axial piston unit and gearbox assembly can be removed from the vehicle from above using a lifting device or from below from an installation pit.

7. Remove the axial piston unit and gearbox assembly. Use a suitable lifting device.
8. Completely empty the axial piston unit and gearbox assembly.
9. Dispose of the hydraulic fluid as necessary in accordance with the environmental regulations of the respective country, see chapter 12 "Disposal" on page 87.

10. Plug all openings.
11. When installing new HRB components, observe the corresponding installation instructions in chapter 7 "Installation" on page 28.

The system may need to be recommissioned after replacing HRB components.

12 Disposal

Careless disposal of the HRB components, the hydraulic fluid and the packaging material could lead to pollution of the environment.
The following points are to be observed when disposing of HRB components:

1. Completely empty the hydraulic components (pressure accumulator, HRB manifold, axial piston unit and gearbox assembly, reservoir).
2. Dispose of the HRB components and the packaging material in accordance with the national regulations in your country.
3. Dispose of the hydraulic fluid and lubricating oil in accordance with the currently applicable environmental regulations in your country. Also observe the applicable safety data sheet for the hydraulic fluid and the lubricating oil.
4. Remove the components from the vehicle, then disassemble them into their constituent parts for recycling.
5. Separate according to, for instance:
   - Cast parts
   - Steel
   - Aluminum
   - Non-ferrous metal
   - Electronic waste
   - Plastic
   - Seals

Before the hydro-pneumatic pressure accumulators are disposed of, the nitrogen they contain must be completely drained, see chapter 10.3 "Maintenance" on page 71.

13 Extension and conversion

The HRB components and their fittings must not be modified. This also includes modification of the setting screws.

The Bosch Rexroth warranty only applies for the delivered configuration. In case of conversion or extension, the entitlement under warranty will be rendered void.

The setting screws are protected against unintentional resetting by means of caps. Changing the settings of the setting screws will void the warranty. If you need to change the setting, contact your responsible Bosch Rexroth Service partner (see chapter 10.8 "Spare parts" on page 85 for address).

A subsequent change of wheel/tire size is possible only upon consultation with Bosch Rexroth. In any case, an adjustment via the diagnostics tool is necessary in order to do this. It may be necessary to replace the HRB control unit (HCU).

14 Troubleshooting

Please contact a Bosch Rexroth Service partner in the event of a malfunction or if you have any questions about diagnosis options and tools. The address can be found in chapter 10.8 "Spare parts" on page 85.
Depending on the vehicle configuration, the error codes can be read out via a diagnostics device (see data sheet RE 94850, section "HRB accessory parts") or via a display if present.

14.1 Easy to rectify causes of errors, self-help

Table Table 18 "Easy to rectify causes of errors, self-help" includes easy to rectify causes of errors. If the described error scenarios occur, perform the corresponding measures. If the faulty system behavior cannot be rectified using these measures, determine the corresponding error code(s) and proceed as described in Table 19 "Error code list" on page 90. Contact your Bosch Rexroth Service partner if necessary.

Table 18: Easy to rectify causes of errors, self-help

Indicator/system behavior	Measure
HRB indicators and HRB without function	Check the HRB fuses and replace any defective fuse(s).
Green HRB status indicator/HRB ready and HRB without function	If the hydraulic circuit of HRB and body hydraulics are identical, actuate the body hydraulics to charge the pilot oil accumulator once.
Yellow HRB status indicator/service	Check whether the return line filter is plugged; perform filter maintenance if necessary.
	Check the oil level in the HRB reservoir.[1)] Add hydraulic fluid if necessary. Use one of the oil types specified in the data sheet.
	Check the HRB fuses and replace any defective fuse(s).

[1)] Check the oil level with completely emptied pressure accumulators. To do this, park the vehicle on a flat surface and deactivate the ignition. Wait approx. 5 minutes before reading the oil level to allow the accumulators to empty completely.

14.2 Error code list

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
–	**HRB behavior:** HRB does not work when ignition on. 5 times sound of a switching solenoid of the empty valve “EV”. **Display (CAN):** - all indicators on - timeout fault of HCU1-message if timeout diagnosis is implemented in display **HRB status indicators (LEDs):** - red and yellow status indicators illuminated for 10 s - other indicator flashing 5 times with approx. 1 Hz **KTS diagnostic tool:** - no fault/P-code - signal "State HRB" == 4 (powerstages switched off) **DCAN:** Send routine of DCAN-messages terminated, values of last sent signals: - State FSM == 7 (powerstages switched off) - Com_stLmpCtl == 31 (all indicators on)	measures see P3186

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
Green HRB status indicator/ HRB ready illuminates but HRB without function	1. Pilot accumulator pressure “Auxiliary accumulator pressure” < 42 bar 2. Signal “HRB-Fct status” - UNEQUAL 0x00 (Normal function) 3. Signal “Engine running” - NOT 4. Signal “ABS monitoring status” - ACTIVE 5. Digital HRB-Level switch 1 (also with analog torque selector) “Retarder lever” - NOT ACTIVE 5a. Digital HRB-Level switch “Current value of retarder stage” - 0 5b. Analogue torque selector “Analogue torque selector: Voltage” - 0 mV 6. “Cruise control” - ACTIVE 7. “Hardware input plausibil. monitoring”: - 1 - Driveshaft speed not plausible - 2 - Pump speed not plausible - 4 - APU high pressure not plausible - 8 - APU swivel angle not plausible - 16 - Voltage of “APS” not plausible - 32 - Voltage of “PPS” not plausible - 64 - Voltage of “AS2” not plausible - 128 - Voltage of “AS1” not plausible 8. Signal “Ignition” - NOT ACTIVE 9. Signal “ADC monitoring status” - UNEQUAL 10. Signal “HRB” - NOT PERMITTED 11. Signal “HRB release status monitoring” - NOT RELEASED (relevant for acceleration with HRB) 12. Drive torque coord. (VMD_trqDes) and HRB specified torque during braking and/or accelerating with HRB - EQUAL 0 NM	1. Load pilot oil supply or see P3016 2. See below: decription of “HRB-Fct Status” 3. Check wiring of “Engine running”: - ACTIVE > 5 V, INACTIVE < 1 V 4. See P3239 5. Activate HRB-torque level switch or analogue torque selector, otherwise see P3214 5a. Activate HRB-torque level switch and check wiring 5b. Activate analogue HRB-torque selector and check wiring 6. Disable cruise control and check wiring: ACTIVE > 5 V, INACTIVE < 1 V 7. - 1 - see P3002 - 2 - see P3003 - 4 - see P3004. P3005 → P30019 → P3186 - 8 - see P3008 → P3024 - 16 - see P3006 - 32 - see P3004 - 64 - see P3008 - 128 - see P3008 8. Check wiring of “Ignition” and fuse “F3” 9. See P3240 10. Is HCU installed in right vehicle? Is the right variant chosen? Further see points 2. 4. 5 11. Check if vehicle speed is in the valid range, a gear is selected (unequal Neutral) and there is no clutch slip (vehicle clutch) 12. Contact Bosch Rexroth-Service
State HRB-Fct	Description of HRB status (on/off): 0x00 - Normal function 0x01 - Deactivation without errors 0x02 - Error without powerstage switched off 0x04 - Error with powerstage switched off 0x08 - No HRB release or monitoring control	0x00 - no troubleshooting needed 0x01 - activate HRB by HRB-button and check if the vehicle is in the valid velocity range 0x02 - solve the problem according to P-Code(s) 0x04 - when no yellow status indicator than see P3186. otherwise see P-Code(s) 0x08 - solve the problem according to P-Code(s)
3000	fault not defined	contact Bosch Rexroth-Service
3001	Global parameter - Value outside tolerance	controller problem → contact Bosch Rexroth-Service
3002	Propshaft speed sensor - faulty	1. check sensor connectivity of driveshaft speed sensor „DS” 2. check the sensor type ("DS"): HALL-speed sensor HDD2L32ND/20-HRB R913005507 3. signal range n = 0...3000 rpm; f = 5...1500 Hz
3003	Pump speed sensor - faulty	1. check sensor connectivity of pump speed sensor „PS” 2. check the sensor type ("PS"): HALL-speed sensor HDD2L32ND/20-HRB R913005507 3. signal range n = 0...3000 rpm; f = 5...1500 Hz

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
3004	Pump pressure sensor - faulty	1. check sensor connectivity of APU high pressure sensor "PPS" 2. check the sensor type ("PPS"): pressure sensor PR2-400GS05/10 R902603033 3. signal range p = 0...400 bar (U = 0.5...4.5 V)
3005	Suction pressure pump pressure sensor - faulty	1. check sensor connectivity of APU suction pressure/temperature sensor “PTS” 2. check signal range - ("PTS") p = 0.5...10 bar (U = 0.5...4.5 V), normal: p = 0.8...1.1 bar (absolute pressure), U = 0.6...0.9 V T = -10...75 °C (R = 9395...374 Ω) ± 5 %
3006	Pressure sensor, accumulator - faulty	1. check sensor connectivity of drive accumulator pressure sensor 2. check the sensor ("APS"): pressure sensor PR2-600GS05/10 R902603034 3. signal range p = 0...600 bar (U = 0.5...4.5 V)
3007	Auxiliary accumulator pressure sensor - faulty	1. check sensor connectivity of pilot accumulator pressure sensor "PAS" 2. check the sensor ("PAS"): pressure sensor PR2-160GS05/10 R902603031 3. signal range p = 0...160 bar (U = 0.5...4.5 V); normal p = 0...75 bar (U = 0.5...2.375 V)
3008	Pump angle sensor - faulty	1. check sensor connectivity of APU swivel angle sensor "AS1"/"AS2" - signal range sensor type DWS10-9 ("AS1"/"AS2"): angle = -15.7...+15.7° (U = 0.42...4.57 V); zero angle: 0° (2.5 V) - signal range sensor type A15 SA ("AS1"/"AS2"): angle = -15.7...+15.7° (U = 0.93...4.07 V); zero angle: 0° (2.5 V) 2. Check functionality of the axial piston unit's ("APU") swivel angle adjustment in both directions.
3009	Oil tank temperature sensor - faulty	1. check sensor connectivity of reservoir oil temperature sensor "RTS" 2. check the sensor: Reservoir oil temperature sensor ("RTS") on oil tank 3. signal range T = -30...130 °C (R = 900 Ω...1700 Ω)
3010	Suction pump temperature sensor - faulty	failure counter measures according to P3005 (combined temperature + suction pressure sensor) ("PTS")
3011	Transmission oil temperat. sensor - faulty	1. check sensor connectivity of gearbox oil temperature sensor ("GT 1"/"GT 2"/"GT 3") 2. check the sensor: Gearbox oil temperature sensor ("GT 1"/"GT 2"/"GT 3") on gearbox 3. signal range T = -30...130 °C (R = 900 Ω...1700 Ω)
3012	Accumulator sleeve temperature sensor - faulty	1. check sensor connectivity of drive accumulator shell temperature sensor "ATS" 2. check the sensor: Accumulator temperature sensor ("ATS") on accumulator surface 3. signal range T = -30...130 °C (R = 900 Ω...1700 Ω)
3013	Return filter - Filter full	1. service and maintenance of the oil filter/reverse flow filter 2. check the filter circuit breaker "FS" - battery voltage (24 V: filter ok) - when filter failure contact open (0 V) 3. check fuse "F3"/"VBAT"

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
3014	Oil level sensor - Fluid level too low	1. check the oil level via the glass sight gauge before commissioning the HRB-System - oil type: conform to HRB specification 2. check sensor connectivity of reservoir oil level sensor “LS” 3. check fuse “F3”/“VBAT” 4. if error occurs in combination with P3134. P3209. P324B, P324E and P3259 → see P324E
3015	Function sequence, engage clutch - Duration too long	1. check the pressure of the auxiliary accumulator (p > 42 bar), if necessary load with auxiliary pump, pressure must be stable 2. check operationality of pilot pressure valve “PV”: specification of the solenoid coil: (voltage, resistance, power, current): 24 V; 28.5 Ω; 20 W; 0.61-0.85 A 3. check operationality of clutch valve “CV”: Specification of the solenoid coil: (voltage, resistance, current): 24 V; 22.5 Ω; 0.7 A visualisation of solenoid current with the diagnostic tool: “Kupplungsmagnet” 4. clutch pressure measurement on gearbox valve block: component 3 in hydraulic scheme, port MB: p_clutch = 27...30 bar 5. speed sensors: check supply, signal and cabling with the breakout box and at the sensor - driveshaft: see P3002 - pump: see P3003
3016	Charge auxiliary accumulator - Duration too long	1. check the prefill-pressure of the auxiliary accumulator (pAccumPrecharge = 30 bar); pilot hose to clutch must be pressureless 2. check the functionality of body hydraulics: pressure > 30 bar must be transferred over change valve (2.1) and pressure reduction valve (2.2) to pilot accumulator (2.5) 3. check sensor connectivity of pilot accumulator pressure sensor “PAS” 4. check connectivity of “external pilot pressure H” and “external pilot pressure L” “EPV”
3017	Auxiliary accumulator pressure - Pressure too high	1. check the automatic discharging on ignition start, if pilot accum. pres. is > 65 bar, pilot pressure valve “PV” is closed for pilot pressure discharge 2. check operationality of the pilot pressure valve “PV” specification solenoid coil: (voltage, resistance, power, current): 24 V; 28.5 Ω; 20 W; 0.61-0.85 A 3. check pressure sensor PR2-160GS05/10 R902603031 (“PAS”): 4. change pilot oil supply manifold (suspicion: DB-valve 2.4 with max. 75 bar defect)
3018	Pump/propshaft speed - Speed comparison not plausible	if failure occurs without P3002. P3003 (sensor failure) and P3228 (plausibility of cardan shaft speed with ACAN-Signal vehicle velocity) possibly clutch slip is present 1. check the clutch closing characteristics 1.1 pilot pressure valve “PV” specification solenoid coil: (voltage, resistance, power, current): 24 V; 28.5 Ω; 20 W; 0.61-0.85 A 1.2 clutch valve “CV” specification solenoid coil: (voltage, resistance, current): 24 V; 22.5 Ω; 0.7 A visualisation of the solenoid coil current in the diagnosis tool: “Kupplungsmagnet” 1.3 check the operation of the hydraulic system an check the pipe works Pressure measurement at gearbox-valve-block Minimess-connection MB at 3.3: p_clutch = 27...30 bar stable

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
3019	Pump/accumulator pressure - Differential pressure implausible	failure occurs if difference between pump and accumulator pressure is too big because of erroneous signals or hydraulic leakage between pump and accumulator 1. check pressure sensors and signals according to P3004 and P3006 2. check hydraulic system: 2.1 check all connections, components for leakage 2.2 check functionality of empty valve “EV”; active if HCU without error specification solenoid coil: 24 V, 22 W 2.3 check functionality of drive accumulator valve “AV”
3020	Pump/accumulator pressure - Differential pressure implausible	See P3019
3021	Pump pressure in neutral - too high	diagnosis: 50 bar for t > 5 s → yellow status indicator 1. check swivel angle signal - see P3008 2. check pump speed sensor - see P3003 3. check the clutch (open, pClutch = 0 bar) 3.1 check operationality of pilot pressure valve “PV” specification solenoid coil: (V: 24 V, R = 28.5 Ω; P = 20 W; Imax = 0.61-0.85 A) 3.2 check operationality of clutch valve “CV” specification solenoid coil: (V = 24 V, R = 22.5 Ω; Imax = 0.7 A) current in the diagnosis tool: “Clutch valve” 3.3 check the operation of the hydraulic system an the pipe work - pressure measurement at gearbox manifold: minimess-connection MB at 3.3: pClutch = 27...30 bar 4. Empty valve electrically interchanged with prefill valve or accumulator valve 4.1 prefill valve or accumulator valve activated when ignition is on but the vehicle is in stand still. 5. Leakage of check valve while body hydraulics is active 6. Leakage of prefill valve 7. Leakage of accumulator valve 8. The pilot oil accumulator cannot be loaded through the prefill valve in the state neutral in less than 5 sec. 9. check pump pressure sensor signal (see P3004)
3022	Pump pressure greater than 320 bar - too high	1. reducing the pressure via adjusting the blow-off valve. Check the operation of the blow off valve while braking (signal “accumulator pressure”) 2. check the blow off valve adjustment and correct the adjustment to max. 305 bar (approx. 95 % SOC) if necessary
3023	Pump suction pressure - too high	- check sensor connectivity of APU suction pressure/temperature sensor “PTS” according to P3005 - check the prefill pressure - check the accumulator bladder
3024	Swivel angle set/actual value comparison - Value outside tolerance	1. check sensor connectivity of APU swivel angle sensors according to P3008 2. check the offset in the neutral-position (sensor-calibration), signal: “swivel angle 1 and 2 pump” 3. check operationality of solenoids: wiring of APU A (motor direction) “SA” and APU B (pump direction) “SB” specification solenoid coil: (voltage, resistance, current): 24 V; 21.7 Ω; 0.73 A auxiliary accumulator supply and pump activation 4. check fuses
3025	Direction of pump/propshaft rotation - wrong direction of rotation detected	- check the speed sensors and signals. - pin configuration: see P3002 and P3003

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
3026	Pump turns when clutch released	1. speed sensor, check signal: P3003 2. check the characteristics of the clutch closing 2.1 check sensor connectivity of pilot pressure valve “PV” specification solenoid coil: (voltage, resistance, power, current): 24 V; 28.5 Ω; 20 W; 0.61-0.85 A 2.2 Verkabelung des Kupplungsdruckventils “CV” prüfen specification solenoid coil: (voltage, resistance, current): 24 V; 22.5 Ω; 0.7 A visualisation of the solenoid coil current in the diagnosis tool: “Kupplungsmagnet” 2.3 check the operation of the hydraulic system an check the pipe works pressure measurement at gearbox-valve-block Minimess-connection MB at 3.3: p_Kupplung (p_clutch) = 27...30 bar
3027	Pressure supply, preload pressure - Preload pressure too low	check the prefill-pressure of the bladder accumulators (use the control set); refill if necessary. If the precharge pressure is back to 120 bar, set the default value for the precharge pressure (115 bar) with the diagnosis tool. Information: without resetting the precharge pressure it is not possible to delete the error
3028	Pressure drop on braking - faulty	1. check the state of the manual discharging valve: is it completely closed? 2. check operationality of prefill valve “PFV”: while braking it is not activated (0 V); solenoid coil specification: 24 V, 22 W 3. check operationality of accumulator discharging valve (“EV”): while braking it has to be activated (24 V) solenoid coil specification: 24 V, 22 W
3029	Pressure reduction in accumulator - Duration too long	1. check operationality of empty valve “EV” if ignition is deactivated: no voltage solenoid coil specification: 24 V, 22 W 2. check the controller feed in during the postdrive: power supply of accumulator pressure sensor: 5 V (see also P3006) pin configuration according to the connection diagram
3030	Transmission oil temperature sensor - Oil temperature too high	- check sensor connectivity of gearbox oil temperature sensor (“GT 1”/”GT 2”/”GT 3”) - crosscheck the temperature
3031	HRB oil - Temperature too low	If the oil temperature is too low, temperature at reservoir or APU < -10°, the system is being deactivated. If the drive accumulator shell temperature is below -15 °C, the HRB will also be deactivated. This state is visualised to the driver by the yellow HRB status indicator/high/low temperature lamp. This is not a failure state. 1. crosscheck the temperatures (reservoir oil temperature sensor “RTS”, APU suction pressure/temperature sensor “PTS”; drive accumulator shell temperature sensor “ATS”) 2. check sensors and signals: 2.1 drive accumulator shell temperature sensor “ATS” 2.2 reservoir oil temperature sensor “RTS” 2.3 APU suction pressure/temperature Sensor “PTS” 3. execute the warm up operation

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
3032	HRB oil - Temperature too high	If the oil temperature exceeds 75 °C, the system will be deactivated. This state is visualised to the driver by the (optional) yellow HRB status indicator/high/low temperature lamp. This is not a failure state. 1. crosscheck the temperatures step by step (reservoir oil temperature sensor “RTS”, APU suction pressure/temperature sensor “PTS”; drive accumulator shell temperature sensor “ATS”) 2. check sensors and signals: 2.1 drive accumulator shell temperature sensor “ATS” 2.2 reservoir oil temperature sensor “RTS” 2.3 APU suction pressure/temperature Sensor “PTS” 3. execute the warm up operation
3033	Maximum number of braking cycles - exceeded	1. perform maintenance according to user's manual 2. reset the counter in the controller with the diagnostic tool
3101	Communication with AccelPedalAngle (ACAN) - Message not plausible	- check message from the body-builder-CAN - GPM14 or EEC2 - interface preparation of the chassis-builder must provide this message
3102	Intelligent battery sensor - above upper limit	check battery voltage : VBAT = 6...36 V
3103	Intelligent battery sensor - below lower limit	check battery voltage : VBAT = 6...36 V
3104	Service brake - signal improbable	Braking signal from the body-builder-CAN and from the hardware-pins is not plausible - check the parameterization according to the interface specification - message CCVS on body builder CAN - check sensor connectivity of pneumatic braking pressure sensor “BPS”
3105	CAN message: brake signal - Brake signal implausible	Braking signal from the body-builder-CAN and from the hardware-pins is not plausible - check the parameterization according to the interface specification - message CCVS on body builder CAN - check sensor connectivity of pneumatic braking pressure sensor “BPS”
3106	SPI and COM error from Cy146 - faulty	controller problem → contact Bosch Rexroth-Service
3107	SPI and COM error from Cy146 - faulty	controller problem → contact Bosch Rexroth-Service
3108	SPI and COM error from Cy146 - faulty	controller problem → contact Bosch Rexroth-Service
3109	SPI and COM error from Cy146 - faulty	controller problem → contact Bosch Rexroth-Service
3110	SPI and COM error from Cy146 - faulty	controller problem → contact Bosch Rexroth-Service
3111	SPI communication in Cy320 driver - faulty	controller problem → contact Bosch Rexroth-Service
3112	Actual/specified HRB torque - dynamics - faulty	check swivel angle signals → see P3008 and P3024
3113	Step test - termination by battery voltage - voltage too high	check battery voltage : VBAT = 18...32 V
3114	Step test - termination by battery voltage - voltage too low	check battery voltage : VBAT = 18...32 V
3115	DIG_A 1 - short to earth/open circuit	check operationality of pilot pressure valve “PV” (via breakoutbox and controller-connectors) specification of solenoid coil: (voltage, resistance, power, current): 24 V; 28.5 Ω; 20 W; 0.61-0.85 A
3116	DIG_A 1 - Temperature too high	→ see P3115
3117	DIG_A 1 - short to B+	→ see P3115
3118	DIG_A 1 - faulty - short to earth/open circuit	→ see P3115
3119	DIG_A 2 - open circuit	check operationality of external pilot pressure valve "EPV" (optional) (via breakoutbox and controller-connectors)
3120	DIG_A 2 - Temperature too high	→ see P3119
3121	DIG_A 2 - short to B+	→ see P3119
3122	DIG_A 2 - short to earth	→ see P3119

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
3123	DIG_A 3 - open circuit/short to earth	check operationality of drive accumulator valve "AV" (via breakoutbox and controller-connectors)
3124	DIG_A 3 - Temperature too high	→ see P3124
3125	DIG_A 3 - short to B+	→ see P3124
3126	DIG_A 3 - short to earth/open circuit	→ see P3124
3127	DIG_A 4 - open circuit	check operationality of empty valve “EV” (via breakoutbox and controller-connectors) specification solenoid coil: (voltage, resistance): 24 V; 22 W
3128	DIG_A 4 - Temperature too high	→ see P3128
3129	DIG_A 4 - short to B+	→ see P3128
3130	DIG_A 4 - short to earth	→ see P3128
3131	DIG_A 5 - open circuit	check the solenoid coil of the prefill valve “PFV” (via breakoutbox and controller-connectors): pin configuration (H,L): 1.22. 1.24 specification solenoid coil: (voltage, resistance): 24 V; 22 W
3132	DIG_A 5 - Temperature too high	→ see P3131
3133	DIG_A 5 - short to B+	→ see P3131
3134	DIG_A 5 - short to earth	1. If error occurs in combination with P3014. P3209. P324B, P324E and P3259 → see P324E 2. → diagnosis as in P3131
3165	EEP read error - Several blocks	controller problem → contact Bosch Rexroth-Service
3166	EEP read error - Several blocks	controller problem → contact Bosch Rexroth-Service
3167	EEP write error - One block	controller problem → contact Bosch Rexroth-Service
3168	Engine brake - open circuit	1. check connectivity of “inhibit engine brake H” and “inhibit engine brake L” 2. ensure the interface preparation
3169	RetCtl_bEngBrkPtd - Temperature too high	→ see P3169
3170	RetCtl_bEngBrkPtd - open circuit	→ see P3169
3171	RetCtl_bEngBrkPtd - short to B+	→ see P3169
3172	RetCtl_bEngBrkPtd - short to earth	→ see P3169
3173	Atmospheric pressure sensor - upper limit	1. crosscheck the ambient pressure 400...1150 hPa 2. contact Bosch Rexroth
3174	Atmospheric pressure sensor - lower limit	1. crosscheck the ambient pressure 400...1150 hPa 2. contact Bosch Rexroth
3175	Atmospheric pressure sensor - above upper limit	1. crosscheck the ambient pressure 400...1150 hPa 2. contact Bosch Rexroth
3176	Atmospheric pressure sensor - below lower limit	1. crosscheck the ambient pressure 400...1150 hPa 2. contact Bosch Rexroth
3177	Communication with nEng (ACAN) - Message not plausible	1. check the body-builder-CAN (bus resistance 60Ω) 2. interface preparation of the Chassis-builder must provide this signal.
3179	Communication with GbxInfo (ACAN) - Message not plausible	1. check the body-builder-CAN (bus resistance 60Ω) 2. interface preparation of the Chassis-builder must provide this signal.
3180	EEPData1 system pressure calculation - faulty	controller problem → contact Bosch Rexroth-Service
3181	Control unit temperature - Temperature too high	Check the temperature of the ECU
3182	HRB button - faulty	1. check the push-button-model according to the connection diagram 2. check the pin assignment of the push-button according to the specification for digital/analogue module
3185	Monitoring module - faulty	controller problem → contact Bosch Rexroth-Service

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
3186	Pressure monitor - faulty	1. check all 3 PWM-solenoid coils 1.1 check operationality of clutch valve “CV”: specification solenoid coil: (voltage, resistance, current): 24 V; 22.5 Ω; 0.7 A visualization of the solenoid current via diagnostic tool: “Kupplungsmagnet” 1.2 check operationality of solenoids: wiring of APU A (motor direction) “SA” and APU B (pump direction) “SB”: specification solenoid coil: (voltage, resistance, current): 24 V; 21.7 Ω; 0.73 A 2. checkup of the pressure sensors (accumulator, pump); this means also to check if the right sensor is mounted. background: difference between pump and accumulator pressure is monitored - accumulator → P3006 - pump → P3004 3. check the blow off valve adjustment → P3022
3187	Monitoring: Actual torque E1/E2 - faulty	1. check the swivel angle signals of the pump like in P3008 braking forwards (loading), magnet B active, in KTS: Swivel angle > 0° (SA1 > 2.5 V, SA2 < 2.5 V) on the D-CAN: Swivel angle is negative (difference to KTS) Accelerating forwards, magnet A active, Im KTS: Swivel angle < 0° (SW1 < 2.5 V, SW2 > 2.5 V) On the D-CAN: Swivel angle is positive (difference to KTS) 2. check the pressure sensors like in P3004 - P3007 3. check the speed sensors like in P3002 - P3003
3188	Monitoring: Specified torque E1/E2 - faulty	1. check the speed sensors like in P3002 - P3003 2. check the operation of the body-builder-CAN and the signals according to the specified interface-preparation (pin assignment: electrical HRB circuit diagram “vehicle/body interface”)
3189	Monitoring: Torque split Diesel/HRB - faulty	check the operation of the body-builder-CAN and the signals according to the specified interface-preparation: CAN-Message for the torque limitation must be available in the following messages: TSC1. KSM1_A, GPM23
3190	Monitoring: Specified/actual torque Diesel E2 - faulty	1. check the operation of the body-builder-CAN and the signals according to the specified interface-preparation (pin assignment: electrical HRB circuit diagram "vehicle/body interface")
3191	Monitoring: Specified/actual torque HRB E2 - faulty	execute the dignosis procedures like in P3187 - P3191 Check the connection of the swivel angle and pressure sensors
3192	Internal power supply - too high	1. check fuse “F3”/“VBAT” 2. controller problem → contact Bosch Rexroth-Service
3193	Internal power supply - too low	1. check fuse “F3”/“VBAT” 2. controller problem → contact Bosch Rexroth-Service
3194	Main relay - stuck	controller problem → contact Bosch Rexroth-Service
3195	Main relay - Switch sticking	controller problem → contact Bosch Rexroth-Service
3196	PWM_A 1 - open circuit	check operationality of solenoids: wiring of APU A (motor direction) “SA” (via breakoutbox an controller-connector; “pumpmagnet A” in the diagnosis tool) specification solenoid coil: (voltage, resistance, current): 24 V; 21.7 Ω; 0.73 A
3197	PWM_A 1 - Temperature too high	→ diagnosis like inP3197
3198	PWM_A 1 - short to B+	→ diagnosis like inP3197
3199	PWM_A 1 - short to earth	→ diagnosis like inP3197
3200	PWM_A 1 - Value outside tolerance	→ diagnosis like inP3197

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
3201	PWM_A 2 - open circuit	check operationality of solenoids: wiring of APU B (pump direction) “SB” (via breakoutbox an controller-connector; “pumpmagnet B” in the diagnosis tool) specification solenoid coil: (voltage, resistance, current): 24 V; 21.7 Ω; 0.73 A
3202	PWM_A 2 - Temperature too high	→ diagnosis like in P3021
3203	PWM_A 2 - short to B+	→ diagnosis like in P3021
3204	PWM_A 2 - short to earth	→ diagnosis like in P3021
3205	PWM_A 2 - Value outside tolerance	→ diagnosis like in P3021
3206	PWM_A 3 - open circuit	check operationality of clutch valve “CV”: specification solenoid coil: (voltage, resistance, current): 24 V; 22.5 Ω; 0.7 A visualization of the solenoid current via diagnosis tool: “Clutch coil - PRV”
3207	PWM_A 3 - Temperature too high	→ diagnosis like in P3206
3208	PWM_A 3 - short to B+	→ diagnosis like in P3206
3209	PWM_A 3 - short to earth	1. If error occurs in combination with P3014. P3134. P324B, P324E and P3259 → see P324E 2. diagnosis like in P3206
3210	PWM_A 3 - Value outside tolerance	→ diagnosis like in P3206
3211	MSC-Fehler in R2S2 vor Lesen - Shortname not found in textmap	controller problem → contact Bosch Rexroth-Service
3212	Analog preselector lever - above upper limit	→ Demanded HRB-torque [Nm] too high → Check connectivity of analogue torque selector → Check the chosen characteristics for the analogue torque selector (preselector lever) in the diagnosis-tool
3213	Analog preselector lever - below lower limit	→ diagnosis like in P3212
3214	Digital preselector lever - Implausible stage	→ Wiring HRB level switch (digital): Proper order: Level 1 → Level 2 → Level 3
3215	Analog preselector lever - signal too high	check connectivity of analogue torque selector signal must be between 0 V and 5 V
3216	Analog preselector lever - signal too low	→ diagnosis like in P3215
3217	RetCtl_bRtdrActv - open circuit	check connectivity of "retarder active H" and "retarder active L"
3218	RetCtl_bRtdrActv - Temperature too high	→ diagnosis like in P3217
3219	RetCtl_bRtdrActv - short to B+	→ diagnosis like in P3217
3220	RetCtl_bRtdrActv - short to earth	→ diagnosis like in P3217
3221	Internal power supply 1 - faulty	Check the sensor supply voltage (5 V): - drive accumulator pressure “APS” - APU swivel angle 2 “AS2” - APU swivel angle 1 “AS1” - APU suction pressure/temperature sensor “PTS”
3222	Internal power supply 2 - faulty	Check the sensor supply voltage (5 V): - APU high pressure “PPS” - Pilot accumulator pressure “PAS”
3223	Internal power supply 3 - faulty	Check the sensor supply voltage (5 V): - Analogue torque selector - Braking pressure “BPS”
3224	Visibility of SW resets in DSM - faulty	controller problem → contact Bosch Rexroth-Service
3225	Visibility of SW resets in DSM - faulty	controller problem → contact Bosch Rexroth-Service
3226	Visibility of SW resets in DSM - faulty	controller problem → contact Bosch Rexroth-Service
3227	Control unit temperature sensor - upper limit	- crosscheck controller temperature (-35...150 °C) - contact Bosch Rexroth-Service
3228	Control unit temperature sensor - lower limit	- crosscheck controller temperature (-35...150 °C) - contact Bosch Rexroth-Service

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
3229	Control unit temperature sensor - above upper limit	- crosscheck controller temperature (-35...150 °C) - contact Bosch Rexroth-Service
3230	Control unit temperature sensor - below lower limit	- crosscheck controller temperature (-35...150 °C) - contact Bosch Rexroth-Service
3231	Communication with ActEngTorque (ACAN) - Message not plausible	- check message from the body-builder-CAN - GPM13 or EEC1 - interface preparation of the chassis-builder must provide this message
3232	Communication with DesEngTorque (ACAN) - Message not plausible	- check message from the body-builder-CAN - GPM13 or EEC1 - interface preparation of the chassis-builder must provide this message
3233	Communication with RefEngTorque (ACAN) - Message not plausible	- check message from the body-builder-CAN - GPM15 or EC1 - interface preparation of the chassis-builder must provide this message
3234	Communication with TSC 1 (ACAN) - faulty	- check signal from the body-builder-CAN - interface preparation of the chassis-builder must provide the TSC1-message.
3235	TSC 1 - Message overwritten - faulty	- make sure that no further body-builder-CAN-participant overwrites the TSC1-message on the body-builder-CAN - crosscheck the interface preparation
3236	CAN data bus F malfunction - faulty	1. If there are no other CAN-errors, check the availability and the functioning of the message from the body builder ECU, e.g. GPM23H or KSM1_AH 2. Check the availablity and function of the Body Builder/Vehicle CAN 3. Check the termination impedance of the ACAN according to e-connections
3237	Communication with vVeh (ACAN) - Message not plausible	Check message from the body-builder-CAN: - GPM13 or CCVS - interface preparation of the chassis-builder must provide this signal
3238	CAN speed and gear with respect to propshaft speed - signal improbable	1. Check body-builder-CAN-Signal vVeh 2. Check sensor and signal from the Cardan shaft speed sensor: → P3002 3. Check rotation of the Cardan shaft 4. Compare in the vehicle and in the chosen variant (menu “adjustments/ settings”): - wheel diameter - differential ratio - gearbox
3239	Monitoring: ABS/ASR diagnosis in run-on - faulty	1. check wiring from vehicle interface (PSM/KSM/etc.) to the HRB-controller: - ABS state - ASR state 2. ensure the correct parameterization of the vehicle interface
3240	Monitoring: Fault in ADC - faulty	1. Check signals from swivel angle transducer [when not connected: between pins 1-3: 5-6 V when between pins 1-2: 24 V (VBAT), between pins 4-6 0 V when between pins 4-5: 24 V (VBAT)] 2. crosscheck the signal from pump pressure signal 3. voltage measure 4. controller problem →contact Bosch Rexroth-Service From version 3: Check the actual value “Status info from ADC monitoring”: 0 - everything OK Bit 2 - Test voltage out of range Bit 4 - Compare test of the swivel angle sensors or pressure sensor not passed Bit 7 - An additional error set
3241	Monitoring: Variant handling - faulty	check the parameterization with the diagnosis tool: chosen variant: menu "adjustments/settings" → variant coding

Table 19: Error code list

P code	Description Diagnostics Tool	Measures
3242	Variant criterion Preselector lever - Version invalid	check the parameterization of the retarder-steps with the diagnosis tool (concerns the analogue torque selector (retarder lever)) → menu “adjustments/settings” → preselector lever
3243	Variant criterion Joint operation - Version invalid	check the parameterization of of the collecting mode in the diagnosis tool: → menu “adjustments/settings” → joint operation (collecting mode)
3244	Variant criterion Parameter set - Version invalid	check the parameterization of the vehicle variant in the diagnosis tool: → menu “adjustments/settings” → variant coding
3247	Fault check SCG pilot pressure valve high	Pilot pressure valve “PV”: check pin “pilot pressure valve H” for short-ciruit to earth
3248	Fault check SCG external pilot pressure high	External pilot pressure valve “EPV”: check pin “external pilot pressure H” for short-circuit to earth
3249	Fault check SCB engine brake not permitted low	Signal “inhibit engine brake”: check pin “inhibit engine brake L” for short-circuit to B+
324A	Fault check SCB green lamp	Green HRB status indicator/HRB ready: check pin “green status indicator L HRB ready” for short-circuit to B+
324B	Fault check SCG green lamp	1. If error occurs in combination with P3014. P3134. P3209. P324E and P3259: see P324E 2. green HRB status indicator/HRB ready: check pin “green status indicator L HRB ready” for short-circuit to B+
324C	Fault check SCG power relay 1	drive accumulator valve "AV": check pin "drive accumulator valve H" for short-circuit to earth
324D	Fault check SCG power relay 2	empty valve “EV”: check pin “empty valve H” for short-circuit to earth
324E	Fault check SCG power relay 3	clutch valve “CV” and prefill valve “PFV” check pins “clutch valve H” and “prefill valve H” for short-circuit to earth
324F	Fault check SCG power relay 4	APU B (pump direction) “SB”: check pin “APU B (pump direction) H” for short-circuit to earth
3250	Fault check SCG power relay 5	APU A (motor direction) “SA”: check pin “APU A (motor direction) H” for short-circuit to earth
3251	Fault check SCB red lamp	red HRB status indicator: check pin “red status indicator L” for short-circuit to B+
3252	Fault check SCG red lamp	red HRB status indicator: check pin “red status indicator L” for short-circuit to earth
3253	Fault check SCB retarder active low	signal “retarder active”: check pin “retarder active L” for short-circuit to B+
3254	Fault check SCB white lamp	white HRB status indicator/launch gear recommendation: check pin “white HRB status indicator L launch gear recommendation” for short-circuit to B+
3255	Fault check SCG white lamp	white HRB status indicator/launch gear recommendation: check pin “white HRB status indicator L launch gear recommendation” for short-circuit to earth
3256	Fault check SCB yellow lamp	yellow HRB status indicator/service: check pin “yellow status indicator L service” for short-circuit to B+
3257	Fault check SCG yellow lamp	yellow HRB status indicator/service: check pin “yellow status indicator L service” for short-circuit to earth
3258	Fault check SCB yellow temperature lamp	yellow HRB status indicator/high/low temperature: check pin “yellow status indicator L high/low temperature” for short-circuit to B+
3259	Fault check SCG yellow temperature lamp	1. If error occurs in combination with P3014. P3134. P3209. P324E and P3259: see P324E 2. yellow status indicator L high/low temperature: check pin “yellow status indicator L high/low temperature” for short-circuit to earth
33FF	KTS connected to Hybrid control unit	contact Bosch Rexroth-Service

15 Technical data

Maximum hydraulic pressure	325 bar (pressure safeguarding)
Operating speed range	approx. 1 km/h to HRB limiting speed (depends on gearbox configuration)
HRB torques on cardan shaft	Depends on gearbox ratio
Hydro-pneumatic pressure accumulator	Satisfies pressure vessel directive 97/23/EC
HRB control unit SRC6-32	Satisfies EMC directive 72/245/EEC
Ambient temperature in operation	-20 °C to 50 °C
Additional weight	approx. 500 kg (depending on system)
System service life	approx. 10 years (for refuse vehicles in rear-loader configuration, 2-shift operations and 200 working days per year) service life of pressure accumulator, in accordance with pressure accumulator system approval

The permissible technical data of the HRB can be found in data sheet RE 94850.

If you do not have the data sheet, request it from your responsible contact partner at Bosch Rexroth.

Further information can be found on website
www.boschrexroth.com/hrb

15.1 Vehicle- and manufacturer-specific details

15.1.1 Mercedes-Benz

Amendment to chapter 5.3 "Operating conditions" on p. 21
Amendment to chapter 5.3.3 "Delaying" on page 21

The function of the HRB level switch is realized using levels 3, 4 and 5 of the retarder lever. Levels 1 and 2 of the retarder lever are reserved for the engine brake.
If the vehicle is decelerated by the HRB, a brake torque output from the combustion engine is suppressed.
The maximum pressure in the system is limited by a pressure-relief valve. On reaching the maximum pressure – the equivalent of maximally charged hydro-pneumatic pressure accumulators – and continued braking with HRB, no more braking energy is stored. The HRB does, however, continue to supply a delaying torque. In such cases, heat is specifically induced into the hydraulic system via the pressure-relief valve until the maximum operating temperature of the hydraulic oil is reached.
The brake torque suppression is then reversed.

Amendment to chapter 5.3.4 "Acceleration" on page 22

The HRB only then triggers an acceleration torque if an HRB level (level 3, 4 or 5) is engaged at the level switch. At the same time, the acceleration torque is independent of the level set at the level switch.

Amendment to chapter 5.3.7 "Driving dynamics" on page 23

The permanent brake/HRB status indicator does not go out when ABS and TCS are active.

Amendment to chapter 5.3.9 "Heat management" on page 23

To prevent excessive temperatures in the hydraulic system, the HRB braking torque is continually reduced after a few seconds both shortly before the maximum temperature of the hydraulic fluid (75 °C) is reached, and when braking with the accumulators already fully charged. The engine brake is reactivated when the HRB limiting torque is exceeded.

Amendment to chapter 9.1.4 "Setting the HRB braking effect", section "Level switch/ preselector" on page 63

The level switch (in the form of the retarder lever) is used to select the intensity of the braking effect of the HRB and of the engine brake. Levels 1 and 2 of the lever are the equivalent to the levels of the standard engine brake. The three HRB levels are selected with levels 3, 4 and 5 (see Fig. 50).

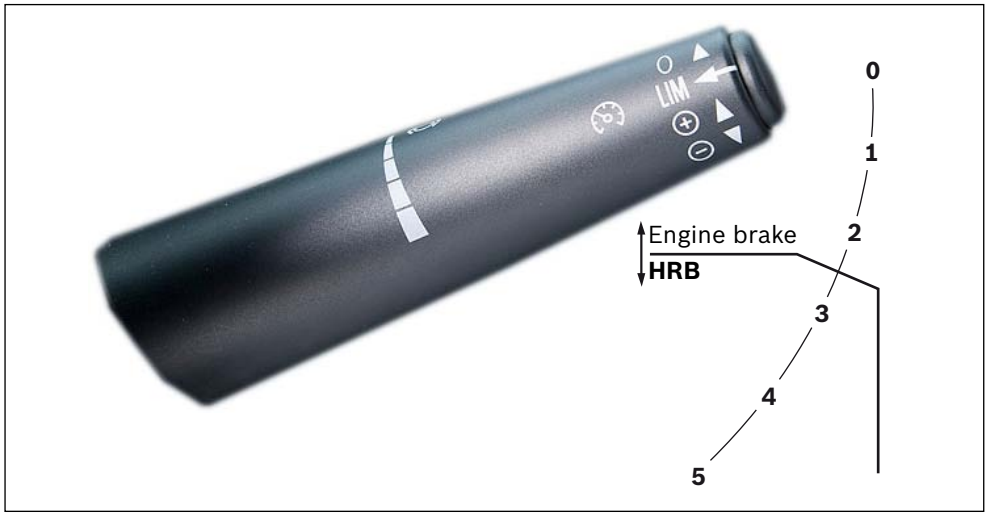

Fig. 50: Level switch - example Mercedes-Benz Actros

As soon as a torque is preselected, the symbol for the continuous brake lights up in the central indicator instrument (see Fig. 27 on page 60). The symbol may flash if the lever was previously pressed while the ignition was on. The flashing will stop if the lever is move once to the neutral position.
Also for start-up support from the HRB, there must be an HRB level (level 3, 4 or 5) pre-selected at the level switch. In doing so, the torque actually triggered is not dependent on the level but rather complies with the driver's prompt. The prompt from the driver is transmitted via, for example, the accelerator pedal of the vehicle.

Amendment to chapter 9.2.1 "Brakes" on page 64

Information: How the engine brake works in levels 1 and 2 of the retarder lever is not described here as this is no different from the function on the standard vehicle.
The HRB is active under a defined vehicle speed of approx. 50 km/h. In addition, In addition, braking is effected with engine brake level 2, regardless of whether HRB level 3, 4 or 5 is preselected.
The capacity of the pressure accumulator is limited. For this reason, the HRB torque is continually reduced on lengthy downhill stretches as soon as the pressure accumulators are charged. The system changes to engine brake level 2.

15.1.2 MAN

Amendment to chapter 5.3.3 "Delaying" on page 21

Engine braking will not be suppressed if the vehicle is decelerated using the HRB.

Amendment to chapter 9.1.4 "Setting the HRB braking effect", section "Level switch/ preselector" on page 63

If the service brake is used, a possible HRB reserve torque is activated up to the maximum possible HRB total torque in order to increase the degree of recuperation.
Fig. 51 illustrates a possible MAN integration of the HRB level switch (**1**).

Fig. 51: Level switch version (e.g. MAN TGS)

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Rexroth
Bosch Group

EC declaration of conformity

(Translation of the original EC declaration of conformity)

Doc. No.: **001**

Date: **03.07.2012**

☐ in accordance with Machinery Directive 2006/42/EC
☐ in accordance with Low Voltage Directive 2006/95/EC
☐ in accordance with EMC Directive 2004/108/EC
☒ in accordance with Pressure Equipment Directive 97/23/EC
☐ in accordance with ATEX Directive 94/9/EC
☐

The manufacturer

Bosch Rexroth AG
Business location: Heidehofstrasse 31, 70184 Stuttgart
Business address: Zum Eisengiesser 1, 97816 Lohr am Main
Registered seat: Stuttgart District Court, HRB23192

Division of Mobile Applications with business location in Glockeraustrasse 2–4, 89275 Elchingen

hereby declares that the product below

Name:	Assembly group: Pressure accumulator system
Function:	Hydrostatic regenerative braking system
Model:	
Type:	HRB series 1, index 0
Serial number:	Ordering code and part number according to delivery note
Trade name:	Hydraulic hybrid from Rexroth Hydrostatic regenerative braking system (HRB)
Year of construction:	since 2009

was developed, designed and manufactured in compliance with the above-mentioned EU directive.

Harmonized Standards applied:

DIN EN 14359

National Standards and Technical Specifications applied:

AD 2000

Notified body that has conducted the EC type-examination procedure in accordance with the above-mentioned directive / approved the full quality assurance system in accordance with the above-mentioned directive:

Name:	TÜV Rheinland Industrie Service GmbH
Address:	Am Grauen Stein, DE-51105 Cologne
Identification number:	0035
No of EC type-examination certificate:	12-K641-2897-058

The individual below is authorized to compile the relevant technical files:

Name:
Address:

Further explanations:

The notes in documents RE 94850 (instruction manual, data sheet, interface description / data network concept and any others) must absolutely be observed.

Place/date/signature as indicated in the original declaration.

We reserve the right to make changes to the content of the Declaration of Conformity. Current issue on request.

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